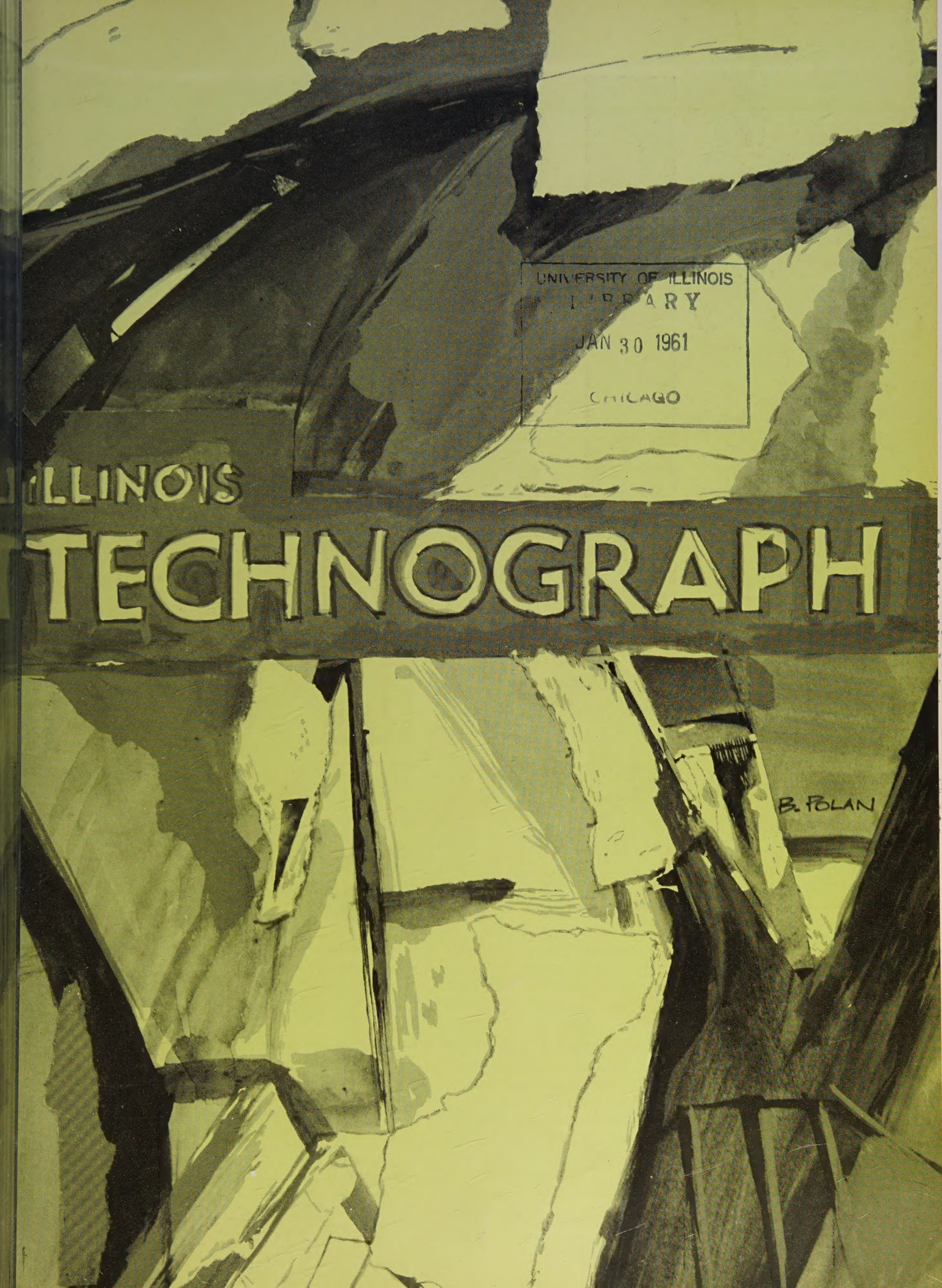

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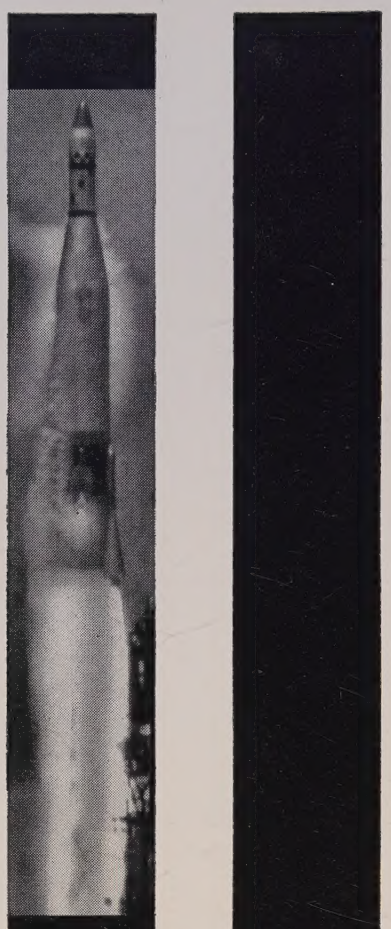

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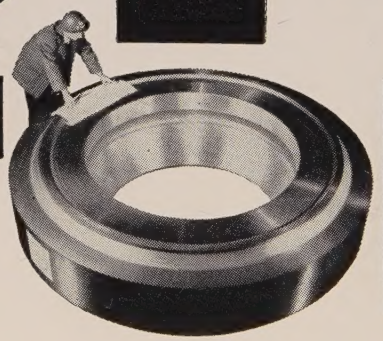

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THE ILLINOIS TECHNOGRAPH

Volume 76, Number 4 **January, 1961**

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Cover . . .

If you look closely at the picture of the University of Illinois' Assembly Hall on Page 20, squint hard, and focus on an upper left region, you may see what inspired our award winning artist, Barbara Polan, as she created the abstract that appears on the cover of this issue. To learn more begin reading on page 20.

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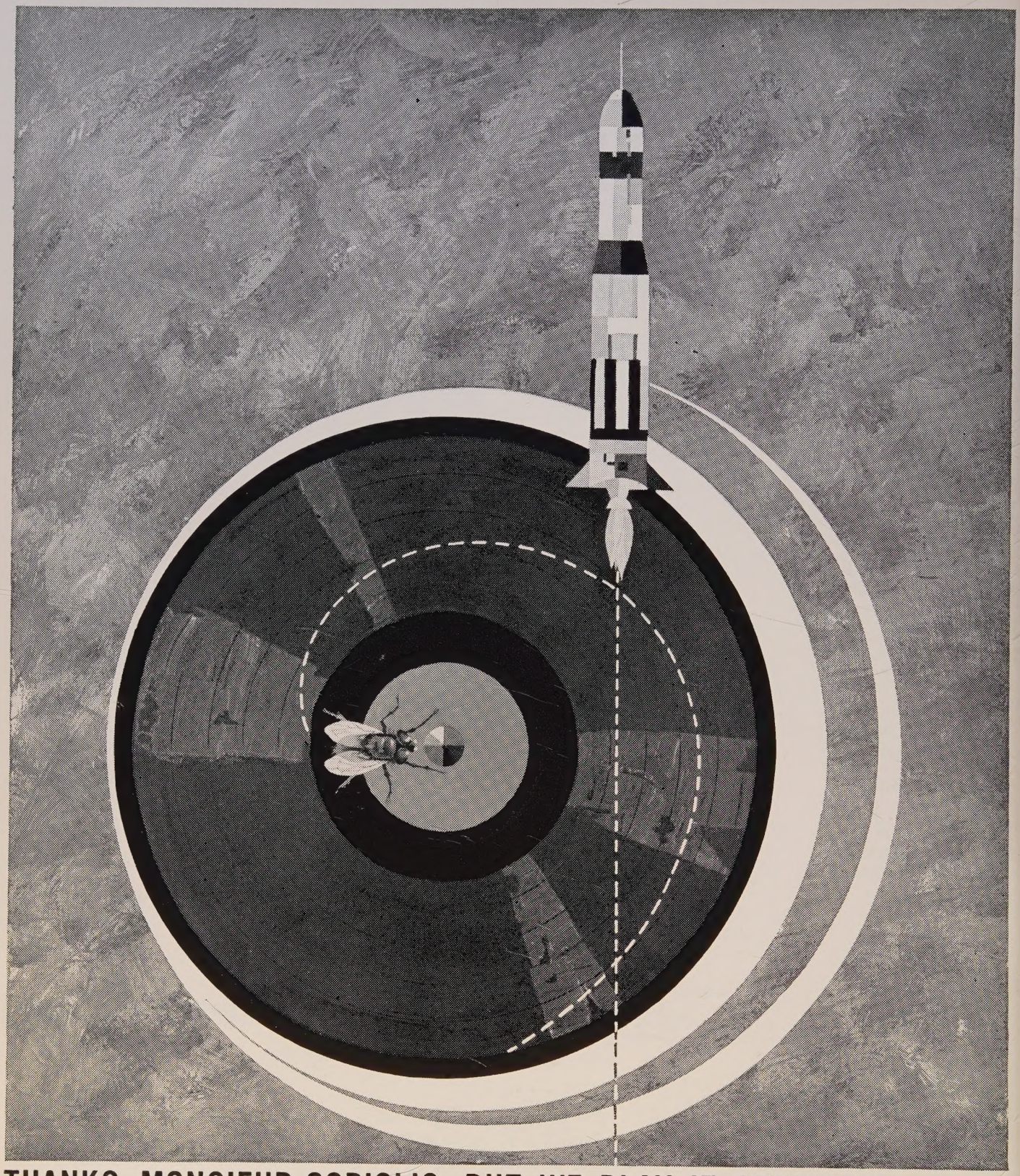

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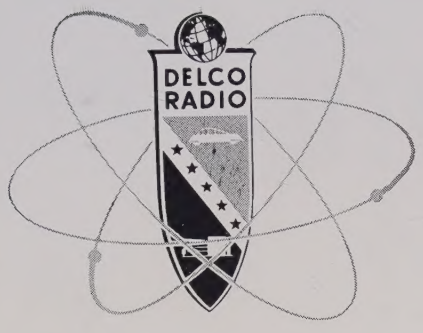

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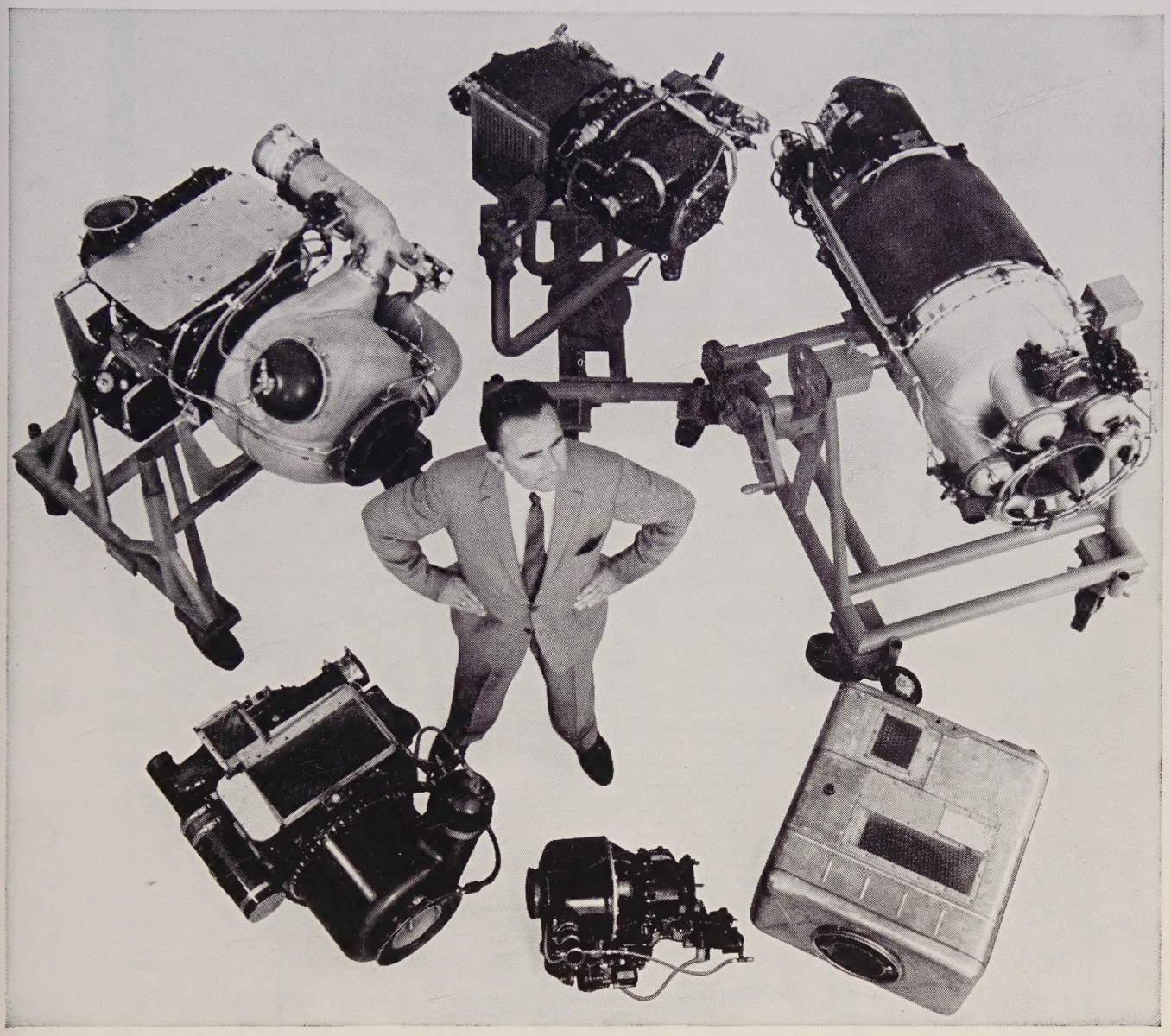
Auxiliary Gas Turbines becoming a prime power source for industry



Helmut Schelp, chief engineer, AiResearch Manufacturing Division of Arizona, Phoenix, surrounded by typical gas turbines now in production ranging in size from 30 to 850 hp. Clockwise from the top: GTC 85-28 GTCP 105 · GTP 70-6 · GTP 30-1 · GTP 70-10 · GTU 85-2.

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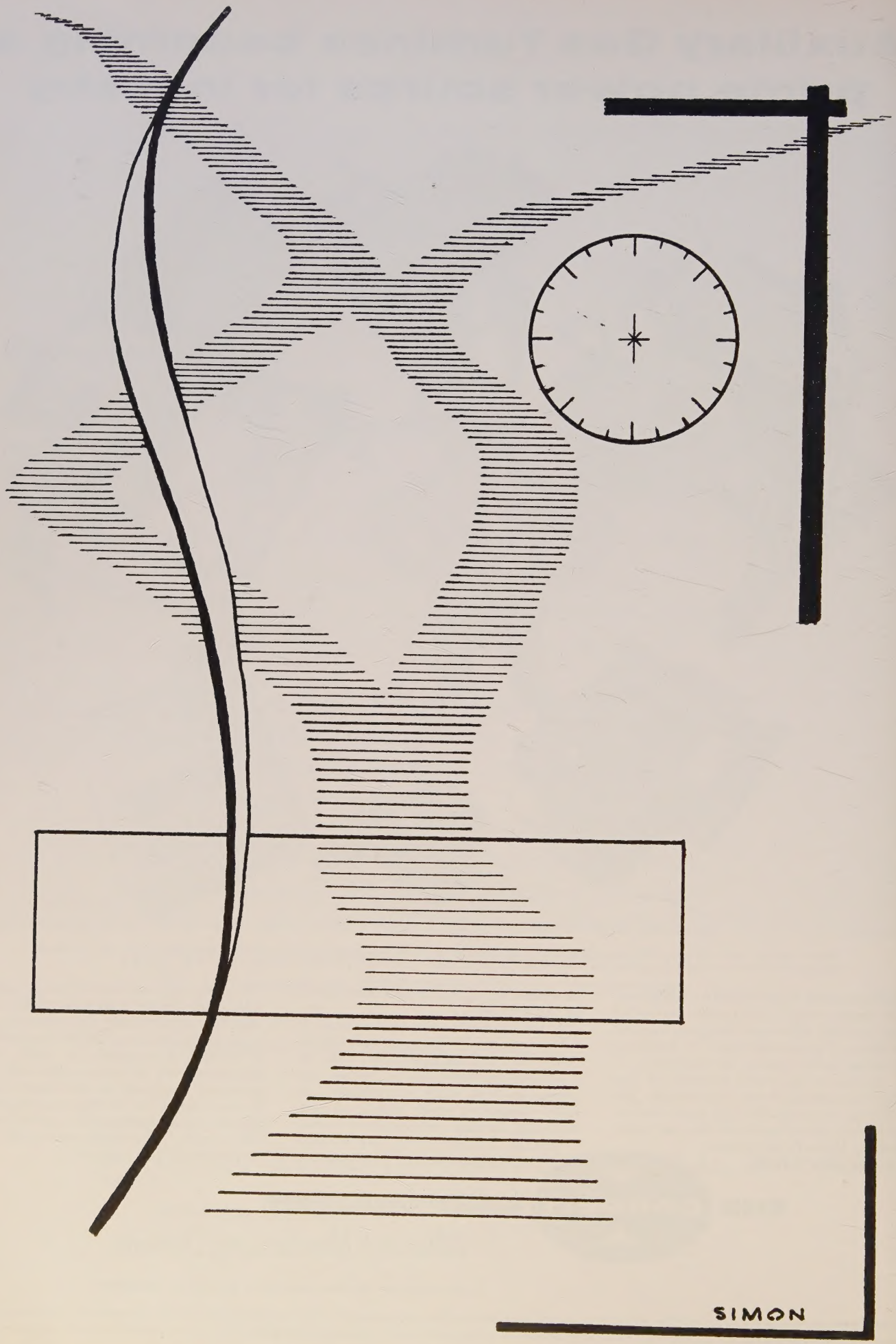

SIMON

The Realization of Time

"Telling" time is one of the early lessons most of us learn as children. Yet it is much later that any real significance of the number of minutes and hours comes to us. As children it meant that when the sands of the clock were in a certain position, we ate; or we napped; or we went to school; or we had to go to bed. Soon time began to take on a third dimension—a depth wherein we could do a certain amount of work, see a movie, or spend in recreation or sports. We looked forward to coming events which would occur in a few minutes, hours, days, or weeks. We have a thermodynamics exam tomorrow at three o'clock. Time stretched out before us like a path leading somewhere—a path that we must travel at a fixed pace. We can glance back over our shoulder to see where we have been, but there is a mist and fog that never allows us to clearly see before us. The only way to be prepared for this unforseen future is to learn from the past, which is familiar.

With thoughtful perception it began to appear that time is associated with change. People grow older; they mature; and the habits and modes of life change from childhood to adult years. This ageing, maturing, and changing process is as irreversible as a frictional, free expansion, mixing process with heat transfer across a finite temperature difference. Many people try to cover this change, but change with time is inevitable. "Hide that gray hair," and "Make your old car run like new" are the advertisers' appeal to this covering up of the changes of time; but attempt to change what you will; time marches on.

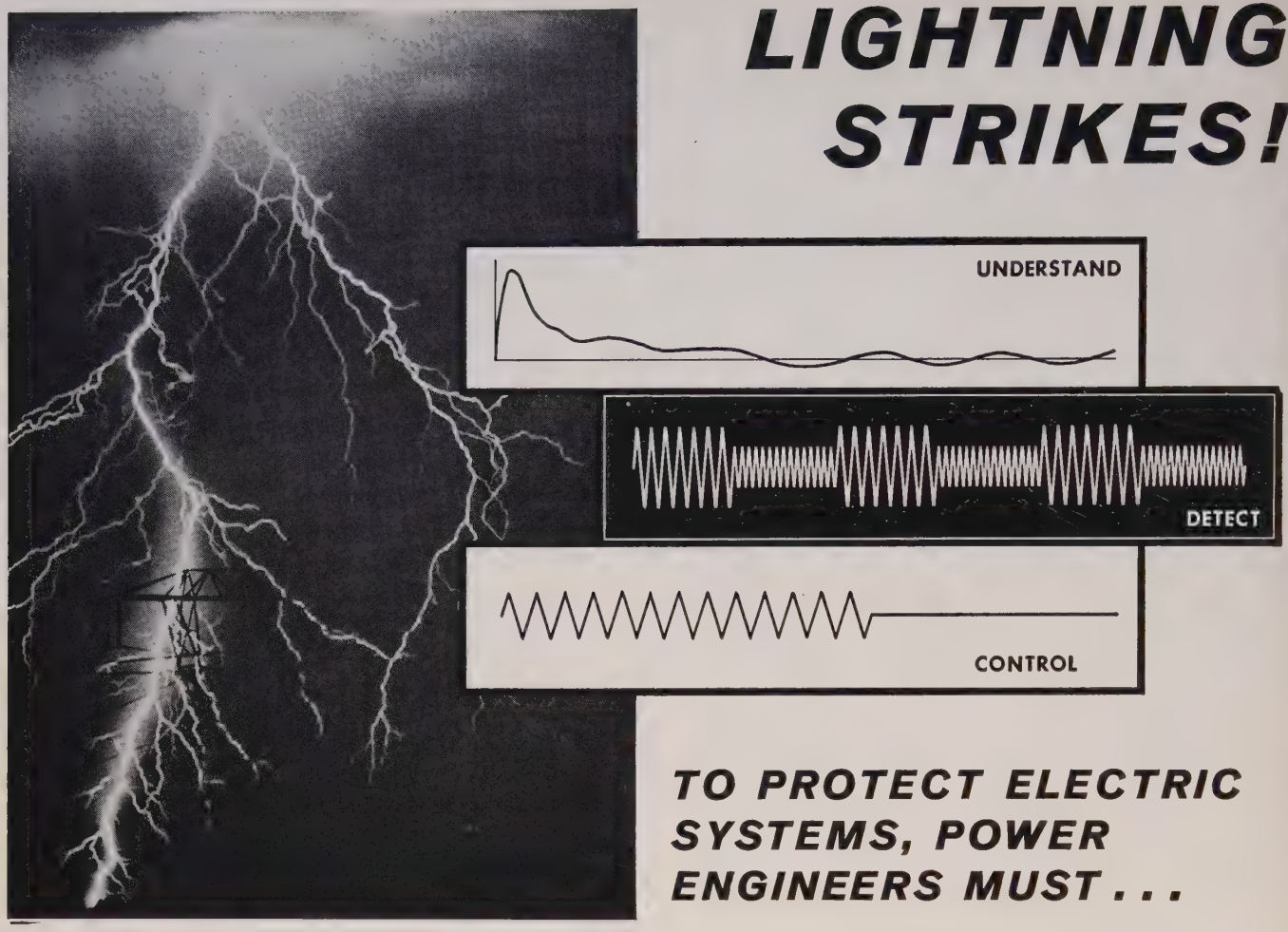
New aspects of time come to mind. It is a measure based on the turns of the earth, divisions of the light of day and the dark of night. There is the past, the present, and the future. Time makes coincidence. If we start out at a certain moment in the morning, we will meet someone at the corner whom we would not meet if we had started earlier or later. If we had lived three generations ago instead of now, how different our lives would have been. What we see on our journey along the path of time is governed by the point we begin and the distance we cover. What we build for ourselves is formed by each and every step we take.

The railroad rails are laid down by a crew that travels along as the tracks are finished, but they have a chance to go back and mend their mistakes. We can only peer back at our errors and try not to duplicate them in the future. Life would be almost too easy if we could go back to repair, but instead we can only build better to counterbalance the flaws in our past.

Yet time is neither something we can get hold of, nor control, though we use it. It seems to repeat itself; yet it does not go in circles, but on and on. Perhaps it does not go at all but is always "there."

—C.H.J.

LIGHTNING STRIKES!



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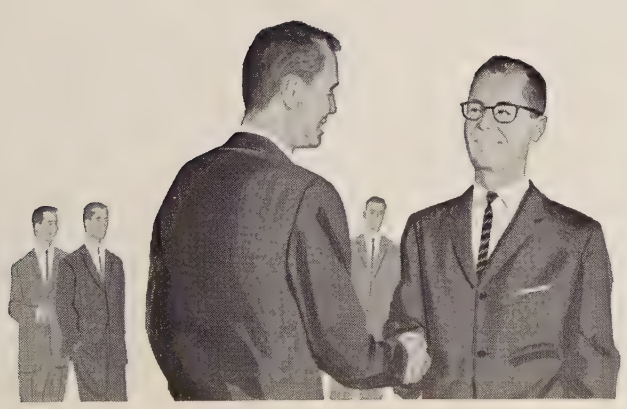

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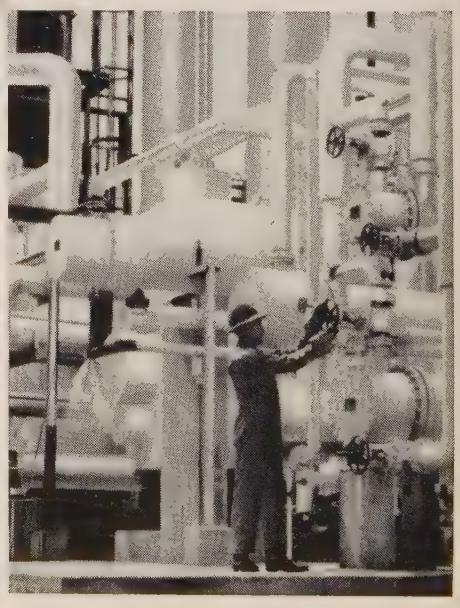

Thermoelectricity:

Applying the Seebeck Effect to Power Generation

by Stephen J. Angello

Project Manager, Thermoelectricity, Westinghouse Electric Corporation

Introduction

Almost 150 years ago the German physicist Thomas Seebeck discovered that the flow of heat through a metal segment could produce a voltage difference between its hot and cold ends. Although this Seebeck effect has since become familiar through its uses in instrumentation, the field of application has been severely limited because of its low voltage and power output.

Quite recently, the development of new thermoelectric materials has enabled us to raise both the power output and the efficiency of thermoelectric devices to levels suitable for the practical generation of power. A year ago, for example, we were working with devices whose output was slightly over 1 watt; today we have generators rated at 100 watts and very soon we will complete construction of a generator rated at 5000 watts.

The qualities of thermoelectric devices that have impelled these developments, particularly for military applications, include ruggedness and compactness and, of course, the fact that the devices are mechanically static. That is, heat is converted into electricity without the need for any moving parts. This freedom from moving parts has several significant implications for defense; for example, in military power plants heat could be converted to electricity without noise. In space vehicles and missiles, the absence of rotating parts would eliminate the gyroscopic forces that occur in rotating machines and so simplify guidance and stability in orbit. As more basic advantages still, the absence of moving parts means that thermoelectric generators are inherently more reliable than rotating machines and perhaps may eventually prove lower in first cost.

The Basic Phenomenon

In any uniformly heated pellet of thermoelectric material its positive and negative electrical charges are uniformly distributed, as in Fig. 1, but when heat is applied to one surface, this distribution is no longer uniform. Although the positively charged ions in the crystals remain fixed, the negatively charged electrons tend to move to the cooler end, as in Fig. 2. This results in a gradient of electrical charge and a potential difference between the hot and cold ends which can cause current to flow in an external load. As we actually use thermoelectric devices, they are arranged in an array of series-connected thermocouples whose materials have been so formulated that their voltages are additive. It is through stacking of elements in arrays that we are able to achieve voltage outputs adequate for power generation.

Materials and Their Parameters

One of the most important factors in the growth of thermoelectric technology is our ability to adjust the number of free electrons in semi-conductor materials. The importance of this is due to two basic relationships: First, the output voltage of any thermoelectric material is inversely proportional to the number of free electrons in that material; and, second, the conductivity of the material is directly proportional to the number of free electrons. Thus, insulators containing 10^{10} electrons per cubic centimeter generate Seebeck (output) voltages in the order of 10,000 micro-volts per Centigrade degree of temperature difference between the hot and cold ends; offsetting this, however, is the fact that they have an extremely high internal resistance. On the other hand, the metals give Seebeck voltages of about 5 microvolts per degree but have extremely low internal resistance. To obtain maximum power output or optimum efficiency from a thermoelectric material we must therefore adjust the electron density for an acceptable compromise value between high voltage and high electrical conductivity. This is essential to the production of useful power since a combination of high voltage and low current or of low voltage and high current result in little power. The compromise is shown by the efficiency curves in Fig. 3 which show the optimum electron density to be about 10^{19} free electrons per cubic centimeter, a value well within the range of good-conducting semiconductors and one which affords Seeback voltages of about 175 microvolts per degree C. Some typical materials which demonstrate acceptable efficiency are zinc antimony, lead telluride, bismuth telluride, and germanium telluride.

In thermoelectric generators built for practical uses we find it is desirable to use a number of different thermoelectric materials to take advantage of the fact that each has its best range of operating temperatures. This contributes to the increased efficiency that is possible when we operate generators at high temperatures. To cover low temperatures, say up to 600 degrees C, we already have several semiconductors which have proved satisfactory. However, to go higher, say into the 1000 degree C range, semiconductors are no longer suitable since at these temperatures they become "intrinsic"; that is, the heat input causes both positive and negative electrical charges to migrate in equal numbers and so no output voltage is possible. As an extreme example, we see in Fig. 4 how bismuth telluride's

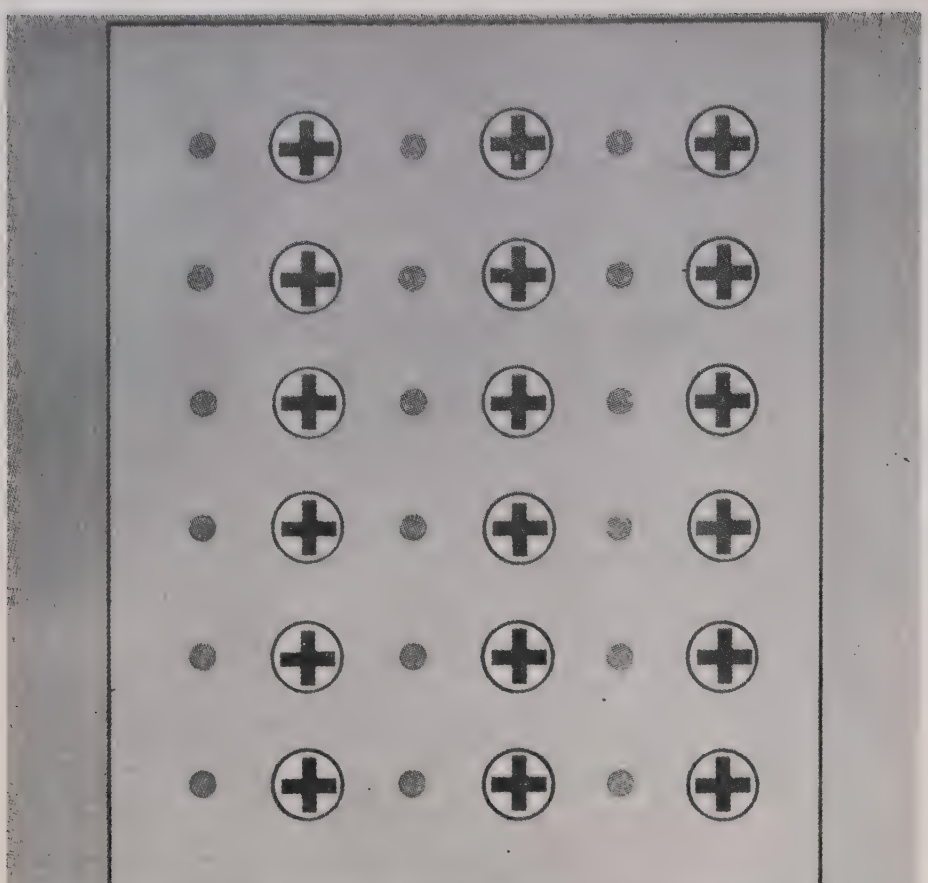

Fig. 1—In a uniformly heated material, the electrons and positively charged ions are uniformly distributed.

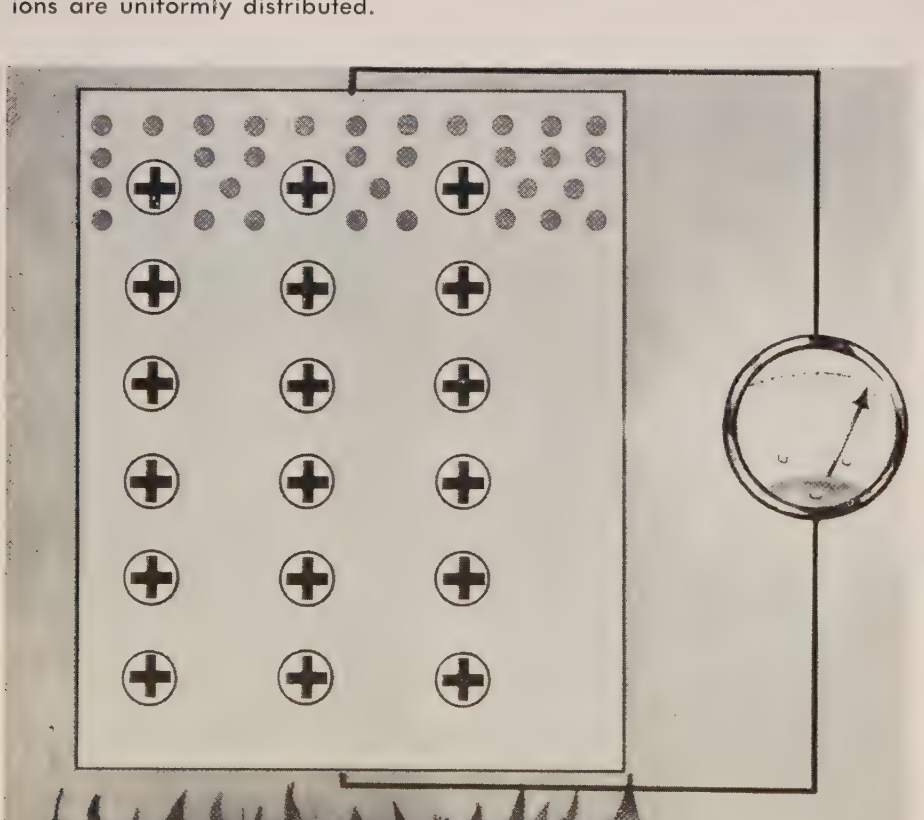

Fig. 2—Distribution of electrons and electrons and positively charged ions as it is influenced over a thermal gradient.

Seebeck voltage falls to zero at 150 degrees C.

Obviously, at higher temperatures we require materials which are free of this behavior. A promising step suggested by Dr. Zener, director of our research laboratories, is the use of insulator materials which have been modified to become good thermoelectric materials. This is particularly interesting since many insulators exist which do not become intrinsic conductors in the 1000 degree C range. As an illustration of this modification, pure nickel oxide is normally an insulator but if it is modified by the addition of three per cent of thium, its resistivity decreases to about 0.01 ohm-centimeters. As explanation for this, in normal nickel oxide the nickel has a valence of plus two but the addition of lithium causes the appearance of nickel with valence of plus one. The material's greatly increased conductivity is brought about by an exchange of charges between plus-one nickel and plus-two nickel. It is through similar modifications that other materials are being developed for use at higher temperatures. For example, this approach led to one of our newest mixed valence materials, samarium sulphide, which has a good figure of merit at temperatures as high as 1100 degrees C.

Devices and Design

Despite these developments, our increasing knowledge of semi-conductors or mixed valence materials does not solve all problems of thermoelectricity for after all, materials are not an end in themselves; they must be fabricated as thermocouples and then be assembled in finished devices. For example, assemblies of thermoelectric materials must be joined so that contact resistance will not be excessive for this would have the same effect as high internal resistivity of the material and would reduce the efficiency. Also, above 300 degrees C it is necessary for thermoelectric materials to be shielded from the air to prevent corrosion of materials and joints. Another aspect of design is the need to mount thermoelectric devices so that they will withstand shock and vibration. One method we have used for accomplishing this is to apply compressive forces through spring-loading systems.

Turning now from the design of thermocouples to the design of complete generators, we are able to draw some interesting conclusions regarding the relationship between power and weight in equipment of the near future. In one of the first generators to be built for the Rome Air Development Center, we produce 100 watts from a 50-pound unit cooled by free convection, for a power-to-weight index of two-to-one. Since performance can be improved consider-

ably by using forced convection of air or water to reject heat, we believe it feasible for generators designed in this way to produce 15 watts per pound of weight, for a power-to-weight index that is comparable to that for a typical, gasoline-powered 500-watt generator.

Other design problems with high priority grow out of our desire to narrow the gap between the efficiency that is theoretically available from known materials and the efficiency that is actually available when these materials are used in equipment. Materials available to us today are capable of an efficiency of about 17 per cent but when assembled as elements of complete generators, the over-all efficiency then becomes about 6 per cent. Much of this loss of efficiency is due to such factors as the stack losses represented by the discharge of heat-bearing gases from the generator's "chimney" and the fact that some of the energy transferred through the walls of the chimney passes around but not through the thermoelectric elements.

Although continued progress in generator design will reduce losses and increase total efficiency, it seems certain that nuclear reactors will be much more efficient in thermoelectric applications than conventional heat sources. With nuclear reactors, it will be possible to have the heat source completely surrounded by thermoelectric elements to eliminate stack losses.

One of the most interesting aspects of the efficiency of thermoelectric generators is that it is independent of power rating, which is of course in contrast to the power-efficiency relation for conventional machines. As Figure 5 shows, small conventional power supplies have an efficiency of roughly 5 per cent, the automobile engine is about 15 per cent efficient, and large diesel engines and marine steam turbines have efficiencies of about 20 per cent. As our most efficient units, large central station power plants have efficiencies of about 42 per cent. At present, the efficiency of today's thermoelectric generators is constant at about 6 per cent regardless of rating. Viewed from the standpoint of efficiency only, thermoelectric devices are thus comparable to conventional power sources in applications up to about 10 horsepower.

As new materials are developed, it seems likely to us that in about five years we will have materials with an inherent efficiency of 30 per cent and we see no reason to regard this 30 per cent as an ultimate ceiling. At the same time, it appears that to achieve efficiency much above this level a major breakthrough will be necessary. As we work with the 30-per-cent-efficient materials we foresee for 1965, we believe now that we

(Continued on page 30)

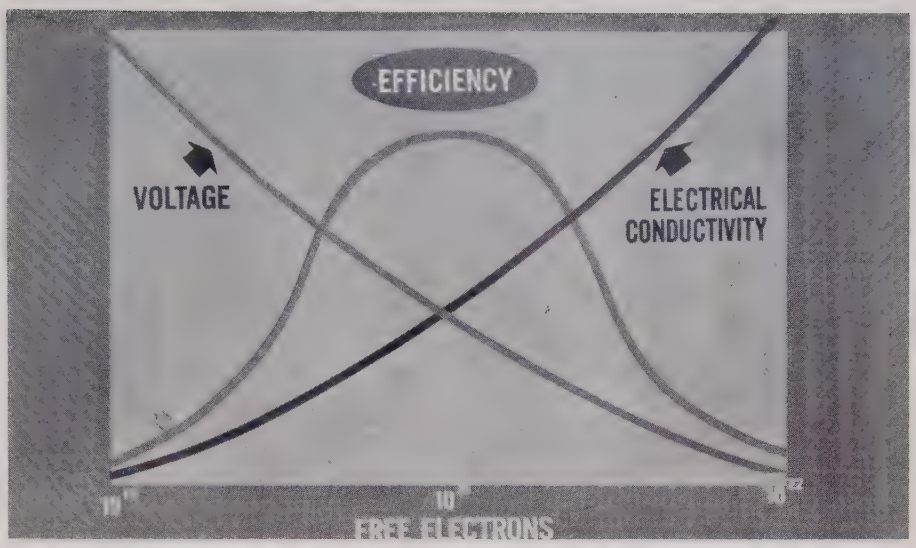

Fig. 3—Relationship between density of free electrons and conductivity and thermoelectric (Seebeck) voltage.

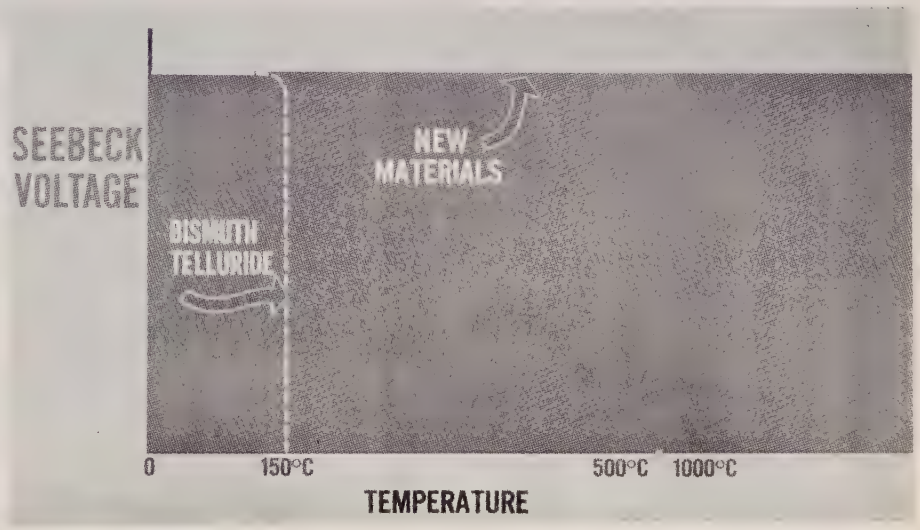

Fig. 4—An extreme example of the manner in which semiconductors become intrinsic at critical temperatures.

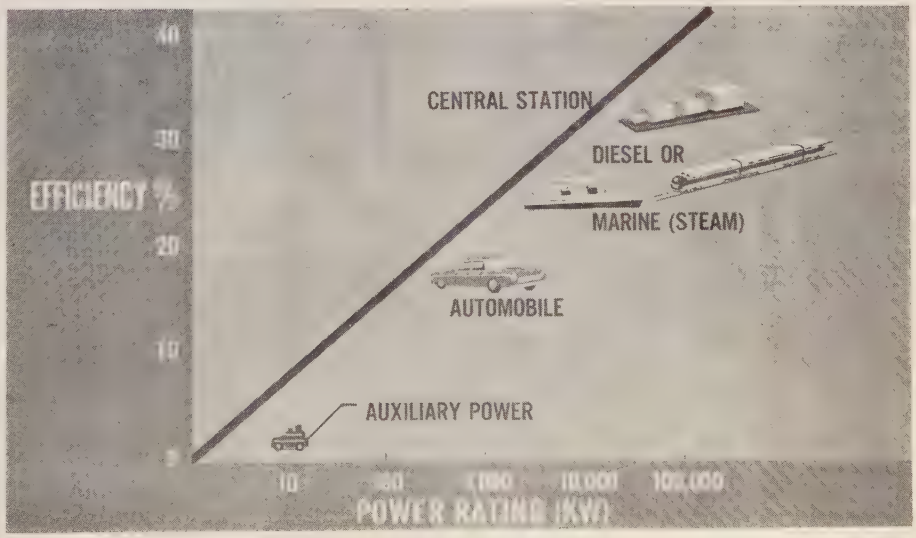

Fig. 5—Efficiency of conventional heat engines as a function of their rating.

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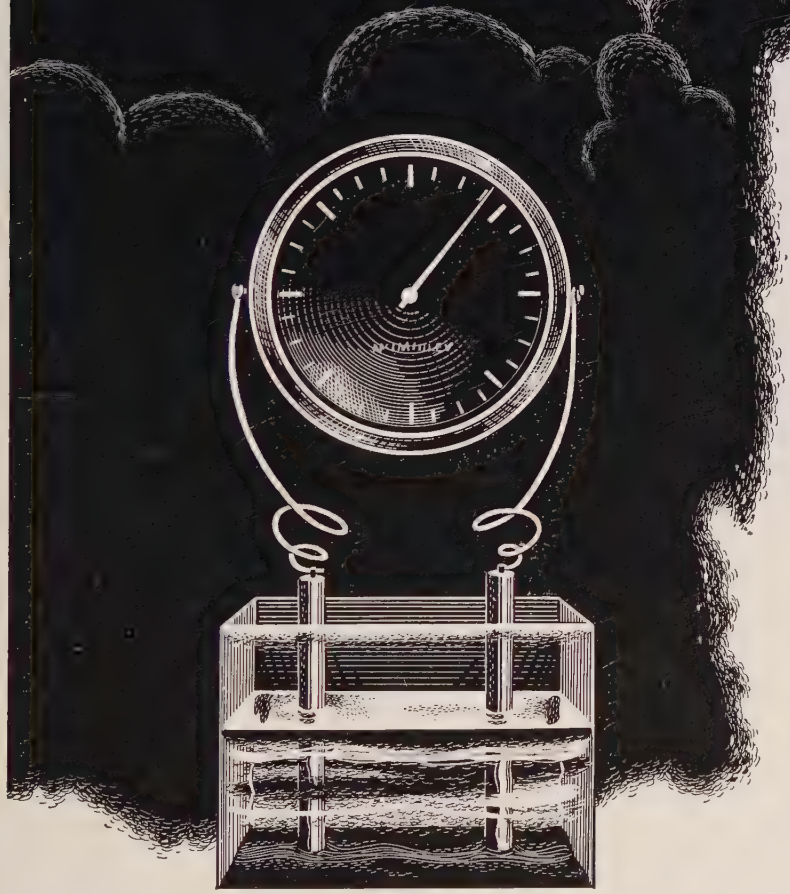

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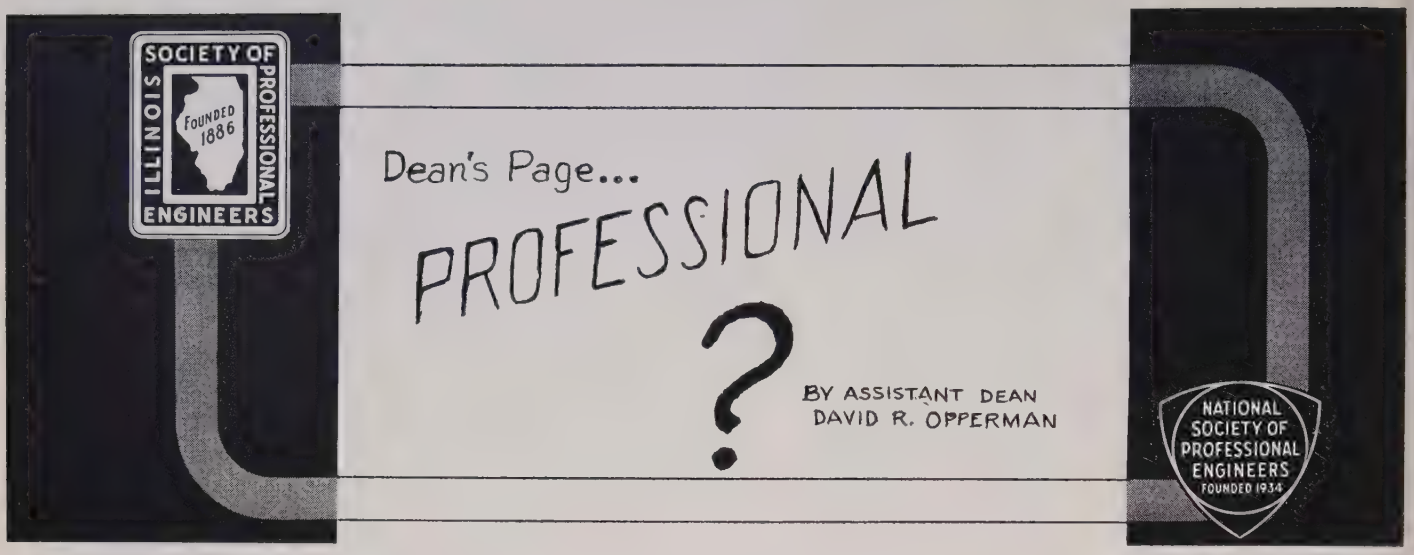

"In order to safeguard life, health and property, any person practicing or offering to practice professional engineering must have evidence that he is qualified so to practice and to be registered as herein after provided." These are the opening words of the Illinois Professional Engineering Act and they state specifically why a professional engineer must be registered—in order to safeguard life, health and property. There are other reasons for registration and advantages to the professional engineer but the primary consideration is the safety of the public. Though your particular engineering function after graduation may not directly involve the safety of the public, you would still be well advised to consider registration as a professional engineer.

Who or what is a professional engineer? The model law drafted by the National Society of Professional Engineers states, "The term professional engineer within the meaning and intent of this Act shall mean a person who, by reason of his special knowledge of the mathematical and physical sciences and the principles and methods of engineering analysis and design, acquired by professional education and practical experience, is qualified to practice engineering as hereinafter defined, as attested by his legal registration as a professional engineer." These words partially describe you now and will undoubtedly fit you after a few years in industry.

The first state to enact a law regulating the engineering profession was Wyoming in 1907. Since that time every state in the Union has enacted such laws as well as territories of the United States and the District of Columbia. This was not accomplished overnight for it took 43 years from the time the first law was enacted until the District of Columbia became the last area of our nation to be covered by such laws. Registration, then, is in its infancy but it is growing rapidly.

In 1930 there were approximately 10,000 registered professional engineers. By 1956 that number had grown to 176,000. Today well over 200,000 engineers are registered professional engineers, over half of those people practicing engineering as a profession. Each year more and more people are registering as professional engineers, especially the younger engineers and new college graduates. A larger percentage of the unregistered engineers are those older engineers who have failed to see the need for registration or who may feel that a theoretical examination would not be fair to them. Most States recognize this situation and examinations for these people are available to test their competency fairly so that the number of the "hold-outs" is decreasing each year.

Registration is here to stay for it has been of proven benefit to the public. Last year 83% of the engineering graduates in the state of Missouri immediately applied for and took the Engineering-in-Training examination. Of the more than 35,000 engineers who received their bachelor's degree last year, the vast majority began first steps toward registration.

But protecting the safety of the public may seem to be a rather nebulous consideration for a busy student who is trying his best to sandwich interviews with companies in between preparation for final examinations. Further, $10 for an examination is still a large sum of money to many of you and you may not be concerned about the safety of the public if it is going to cost you a ten dollar bill. Therefore, many students wish to have more specific reasons for considering the first steps toward registration. Some of these reasons follow.

First, registration gives you authority to practice as an engineer before the public. If you have a job, the pay check that company "X" is going to give you may seem to be all the authority you will need. But isn't this a rather short sighted view? Are you sure that you will always be in this position? Maybe in a few years important advancements may hinge upon the factor of registration alone. A golden opportunity may slip by you because you had failed to register as a professional engineer.

Secondly, registration establishes a professional standing for you according to legal requirements. These requirements, though they are minimum, are accepted by everyone since they are legally recognized and have been tested in the courts. Thus, your standing is well defined and assured. In addition, you are protected by law from the unqualified who would try to use the title. The law also distinguishes between you and "locomotive enginemen" and others who are commonly called engineers.

Many of you may be engaged in engineering work that does not require registration for the daily tasks you perform. Teaching in an engineering school is an example of this. But you have automatically limited your range of activities since, if the occasion arises, you would not legally be able to act in a consulting engineering capacity. Further, there are specific instances where you would be denied the privilege of acting in an engineering capacity, such as testifying in court, simply because you had failed to register. Thus, registration is not only in the best interest of the public at large, but it is also very specifically in your own best interest.

A few paragraphs ago I mentioned that registration certifies only to minimum qualifications. We all advance in our profession on the basis of our capacity to perform creditable work, or else we find that we do not advance. Your preparations for a career in engineering must continue on after you leave school. Thus, year by year, you increase in stature and in ability to perform an engineering service for the public. Ultimately your level of competency is far above the minimum standards for registration. However, if you have failed to register, this competency is not legally recognized. A minimum standard must be established to eliminate the quacks and the ill-prepared from foisting their efforts on the public. Regeistration does protect the public and the profession from such people by establishing these standards. Graduation from an accredited engineering school, such as the University of Illinois, is one step toward meeting these minimum qualifications for registration and it would be folly for you not to capitalize on your progress to this point by failing to start the registration process before you go out into industry.

The thought of registration scares many student engineers since they are now concerned with courses in senior design that may not be utilizing some theoretical subjects such as fluid mechanics, thermodynamics, etc., in a very specific manner. Students get "rusty" if they do not use their knowledge day by day. Triple integration may cause quite a problem for you today whereas it may have helped you "ace" an all important hour axam when you were a sophomore. Because of these factors, I am afraid many graduating seniors hesitate to sign up for an examination that may reveal some weaknesses that have occurred simply through the passage of time.

Such anxieities have been recognized by local student groups in mechanical, civil and electrical engineering. They have organized refresher courses specifically for those students who wish to take their theoretical examination for registration. These courses will be taught during the Spring Semester 1961 and you should watch the bulletin boards for dates. They usually consist of one evening session per week for five to seven weeks duration.

A typical review course offered recently had the following outline:

Session I—Hydraulics, Specific Gravity

Session II—Dynamics - Kinetics and Kinematics

Session III—Heat Problems, Gas Laws, Chemistry

Session IV — Machines, Efficiency, Engines, Thermal Stresses

Remember . . .

ENGINEERING OPEN HOUSE ISSUE

Next Month

Session V—Mathematics

Session VI—Electricity, DC and AC Circuits, Motors

Successful completion of this course does not guarantee a passing grade on the examination but I can assure you that those who have taken the refresher courses have enjoyed a much higher degree of success on the examinations than those who didn't.

The National Society of Professional Engineers, in general, and the Illinois Society of Professional Engineers, specifically have sponsored review courses for engineers in industry through the University of Illinois Extension Division. These refresher courses enable the practicing engineer to "bone up" on the theory behind his engineering practice. The portion of the registration examination which is based on theory then becomes a more easily obtainable goal. Refresher courses have been offered at 20 or 30 locations throughout the state of Illinois for practicing engineers. These courses are taught by members of the staff at the University of Illinois. Courses are offered at any location requested if 15 or more persons signify an interest in registering for the course. This program has been in effect since 1949.

How Do I Register?

Graduation from the University of Illinois and passing the theoretical examination will qualify you for a certificate as an "Engineering-in-Training." The steps that you would take to accomplish registration as a professional engineer would be as follows:

1. Take a refresher course if you feel it is necessary.
2. Apply for and take the Engineering-in-Training examination. Deadline for filing is April 4, 1961, and the examination will be given on May 4, 1961.
3. Engage in at least 4 years of professional engineering work in the field.
4. Apply for and take the final examination for registration which is based on a demonstration of professional calibre engineering accomplishments.

That most important step, passing the theoretical requirement, can be taken while you are still on campus. If you fail to do this now, it can only be more difficult for you in later years when you decide that you do wish to become a registered professional engineer. "Strike while the iron is hot" could not be a more apt expression for the engineering senior soon to embark upon his professional career.

Engineering students at the University of Illinois are particularly fortunate to have a member of the State Board of Engineering Examiners on our campus. Prfofessor W. W. Hay in the Department of Civil Engineering has recently been appointed to the State Board filling the vacancy created by the death of the late Professor T. C. Shedd. Professor Hay is always glad to discuss registration with anyone who desires more information about the subject. His office is located in Room 310 Civil Engineering Hall.

Two very interesting and informative publications are available from the National Society of Professional Engineers, 1121 15th Street NW, Washington 5, D.C. These publications are "Next Step —Registration," and "Q and A About Registration for Engineers in Industry." The former publication is of special interest to the senior in engineering, since ti outlines specifically the steps to take toward final registration as a professional engineer. The latter publication is of primary interest for the engineer in industry, as the title indicates. However, much information of interest to anyone planning a career as a professional engineer may be found in that publication. I hope that you will acquire at least one of these publications and read it critically in an effort to arrive at a decision as to whether or not you should register as a professional engineer.

Many states have established a system of reciprocity with regard to registration as a professional engineer. Reciprocity means that special concessions are granted to professional engineers of another state when that particular state grants special concessions to registered engineers of our state. Reciprocity does not mean that the state of Illinois relaxes minimum standards for registration simply because an engineer already has a certificate from another state. The out-of-state engineer must be as qualified as any other person registering under our Act, but the process is simplified and streamlined for him. In like manner, if you are registered in our state and your career takes you to another part of the United States, you may find that registration in your new home will be greatly facilitated because of your recognized standing as a professional engineer in the state of Illinois. Begin to plan now for that all important next step—Registration.

Where do you go from here?

We're not looking for a direct answer.

This is just to remind you that a good knowledge of miniaturization is worth having — wherever you go in the world of engineering.

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THE SOUND OF *Doom!*

Science Fiction

by Barbara Pierce

John Redmon sat up in bed and turned his head slowly from side to side. He tried to detect where the faint buzzing, which had awakened him, was coming from. After several minutes, he pulled on his robe and began searching the apartment. Ten minutes went by, and he had found nothing. Twenty minutes, and his head was throbbing under the constant buzz, buzz, buzz. He stumbled back towards the bedroom, clasping his hands over his ears. But it continued and mushroomed from a faint murmur to an ever-increasing roar.

Then John brushed against a table, sending a lamp crashing to the carpet. He clung to the door frame for support as the living room spun around him. Just as Karen, his wife, rushed from the bedroom, he slumped to the floor. She knelt beside him and called his name. When he didn't respond, she rose to call the doctor.

"Doctor Jamison, this is Karen Redmon. John has passed out, and I can't rouse him. It must be the buzzing again. Please hurry!"

As Karen replaced the phone, she began crying in short, gasping sobs. Then she forced back her tears and rushed to the kitchen for a cold cloth. She returned to find John staring at the ceiling, his forehead covered with sweat and his whole body trembling with fear.

"John . . . John, are you all right?"

Not noticing his wife, he began lashing the air with his arms, like a drowning man coming up for the last time. Then he spoke in a loud, pleading voice.

"Stop! Stop! Don't punish me any more! I had to leave you. I had to save myself. I couldn't have helped you; nothing could have."

He repeated the words over and over, while Karen merely stood by his side and waited for the doctor. She had been told before not to touch or talk to him until someone was there to help her.

Finally the doctor arrived and gave John an injection to quiet him. Then the doctor and Karen managed to get him into bed. They made him as comfortable as possible, and they went into the living room.

"I don't know how much more I can take. Every time is worse than the last. I can't stand seeing my husband go insane and doing nothing to help him."

"I know it's hard. But there's nothing we can do. You know that! He doesn't even realize what the buzzing is when it starts or that he's heard it before. When he comes out of that faint, he just remembers how he left those six dying men up there."

"But why should there be any buzzing? Why should he feel guilty? He couldn't have helped those poor devils. It was just chance that he didn't leave the space ship when they got to the moon. If he had, he would have been killed by those insects, too."

Her voice trailed off. Suddenly she thought he wouldn't be suffering now. The psychiatrists had been able to find out what had happened on the moon, but they had failed to stop the buzzing. No, nothing could rid John Redmon of this sound of doom except death.

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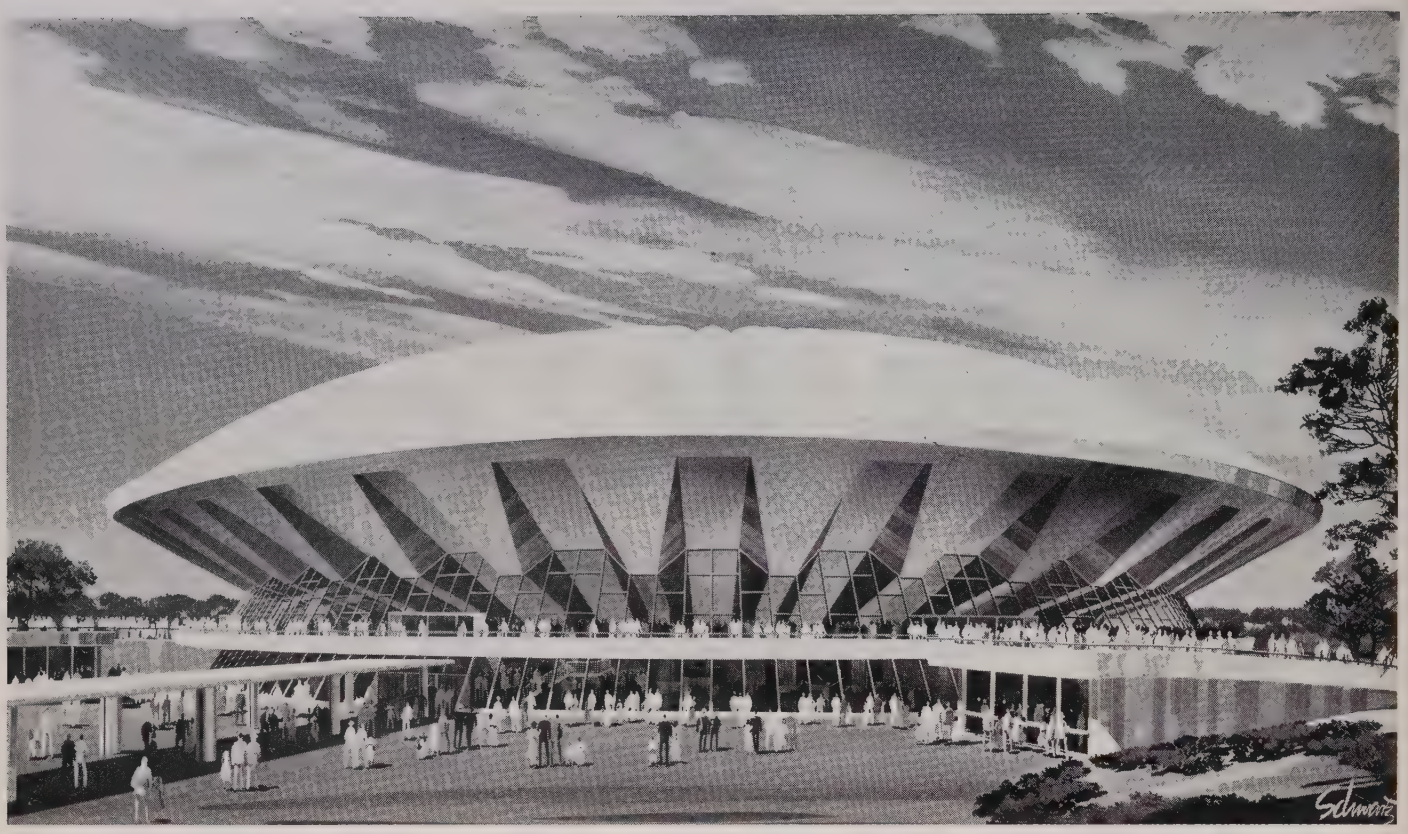


Our Changing Campus

by Bob Podlasek, C. E. '64

Unique in concept, design, and construction is the University of Illinois Assembly Hall now being built just south of Memorial Stadium. Perhaps the most impressive fact about this building is that it will have the world's largest reinforced concrete roof without central supports.

The domed building, shaped much like two saucers one inverted over the other, will be 400 feet in diameter and rise 100 feet above surrounding terrain. Seating and central area will dip into the ground so that the dome will arch 130 feet above the floor inside.

The hall is planned for a multiplicity of uses—theater, ballet, symphony, convocations, commencements, conventions, sports. It will seat 16,500 for events such as basketball, which demand the entire floor area, and will seat another thousand for events such as lectures or convocations when the floor space also can be occupied.

One-half of all the permanent seats will be below ground level. This eliminates balconies and excessive climbing to reach the seats. Multiple exits around its circumference will enable it to be filled or emptied in brief time.

Circling the building at ground level will be a glass and steel enclosed concourse 30 feet wide, 1,100 feet in total length which also can be used as display space for events such as the Illinois State Junior Academy of Science meeting held annually on the Illinois campus.

Built-in facilities will provide for television and radio broadcasting and for press coverage of events, and will even include a service elevator capable of bringing a truck or an elephant to the main floor if desired. Observation booths and a small studio with transmission over university or commercial channels are also included for originating radio and television broadcasts.

The building is supported on a continuous ring footing located thirty feet below grade and forming the foundation for 48 supporting buttresses. Between the buttress formations, light weight reinforced concrete construction will support the permanent seats.

To prevent the accumulation of water during the first stage of building, ground within the bowl has not been excavated and a 100-foot temporary steel tower has been built here to support the center of the dome during construction.

The dome, which will be constructed of lightweight concrete, will be poured in segments, with those opposite each other made at the same time to keep the structure balanced. Each dome segment will have a series of complex corrugations or folded plates, for both strength and accoustical purposes.

A tension ring of 505 miles of 3/16-inch hard drawn steel wire will circle

the dome. This tension ring will contain the horizontal stresses and transfer all forces to the buttresses below. A 10-inch I-beam will be installed around the circumference of the dome to mount and operate a winding machine weighing approximately 10 tons. The wire will be stressed to 120,000 pounds per square inch during the winding operation. This whole winding process will take six continuous weeks, and must be accomplished when the temperature is not lower than 40 degrees with variations not greater than 15 degrees. The tension ring will have a total cross sectional area of 85 square inches and be entirely encased in "Gunite" concrete on completion.

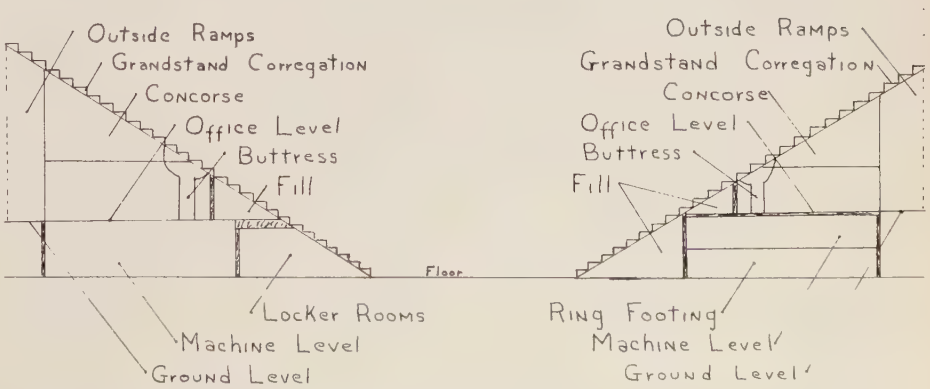
During the process of "tensioning" the ring, the center of the dome will be raised three inches above the forms on which the sections have been cast to allow more efficient disassembly of the forms and the 100-foot tower. After these have been disassembled, some 35 feet of earth inside the structure will be excavated and the bowl and seating completed.

Electrical service facilities will be served by three dry-type transformer vaults with total capacity of 3,000 kva. Dual secondary voltages of 120/208 volts, 3 phase, 4 wire, wye will be used for general lighting, and 440 volts, 3 phase, 3 wire delta for power distribution. Overhead illumination will be supported from a steel grid or service catwalk system 85 feet above the finished floor, and include many different types of fixtures as required for the various uses of this unique building.

Mechanical heating and ventilating systems will be of low velocity air distribution type. Offices and public rooms to be located on a level beneath the concourse will have hot water radiation on exterior walls. Supply fans will be located in equipment rooms on north and south sides of the building. At present air conditioning will not be installed for the auditorium.

There is nothing in the world today like this building, and its construction is a structural engineering feat. Harrison and Abramovitz of New York are the architects and Siska and Hennesy of New York, the mechanical and electrical engineers. Ernest L. Stouffer is the university architect, and Felmley-Dickerson Co. of Bloomington and Urbana, headed by Ray Dickerson, a member of Champaign County Chapter, Illinois Society of Professional Engineers, are the contractors.

Construction of this $7,500,000 building started May 25, 1959, and is scheduled to be completed by September 1, 1962.



Profits from Shiny New Coins

by Carl Stehman, '61

In the past five years some wise people have been investing their money at the nearly unheard of rates of 20% yearly and greater! Many of these investments cannot possibly drop below par value, and can be recovered at original cost (no broker's fees either) upon a moment's notice. Profits are capital gains, and hence are not taxed at a rate greater than 25%. Capital required may be as low as 50c and everyone with access to a bank can make these investments by merely purchasing rolls of shiny new coins.

Every year, billions of these brilliant coins tumble out of the United States' minting machines and, by way of our banking system into the hands of stores and their customers. Recently investors have been buying rolls of these mint new coins, and the results of their investments have been rewarding. Those who spent 50c in 1955 for a roll of shiny new pennies are now able to sell that roll for at least $4.00, and perhaps $7.00 depending on where the pennies were made. Mint new nickels bought in 1950 are now worth $50 a roll and perhaps $150, again depending on where they were minted.

To explain the spectacular rise in value of these coins, we must explore briefly the world of coin collectors, sometimes known as numismatists (a treacherous word to pronounce).

Of the more than two million numismatists in the United States, a majority average at least three hours a week trying to improve their collections. This improvement is made in two ways simultaneously.

First, "another hole is filled." This means the collector has acquired a coin to fill an empty hole in his display board or folder. Four clues determined what coin was needed to fill that hole.

The first clue is denomination of the coin-penny, nickel, dime, or what? Perhaps it is one of the now extinct denominations such as twenty cent piece, a three dollar gold coin, or a half penny. Display boards and folders are designed so that a given denomination coin fits snugly into a hole of the proper size.

Second clue is the coin's date—this is usually printed on the display board under the hole for the particular coin. The United States Mint first officially minted coins in 1792, and has minted them in at least one denomination every year since then. The date of mintage is found on the heads side of every one of these coins with the exceptions of one dollar gold, three dollar gold, some commerative coins, and coins that are worn so smooth that the date is no longer readable. None of these concern the investor interested only in modern uncirculated rolls.

As a third clue it will be noted that a small letter follows many of the dates printed on the display board. This letter, called the mint mark, is an abbreviation for the location of the mint at which the coin was made and is found near the date or on the tails side. If there is no mark, either on the display board or on the coin, the coin was minted at the United States' main mint which is located in Philadelphia. The only other mint which currently in operation is the branch mint at Denver whose mint mark is D. Until late 1955 a branch mint was operated at San Francisco and used the mark S. Other branch mints, all of which were closed more than fifty years ago, are New Orleans (O), Carson City (CC), Charlotte (C), and Dahlonega (D, gold only).

The fourth clue is type and variety. Usually collections are assembled in series of a single type or design coin such as the Lincoln cent or the Wash-

ington quarter. Within the type, varieties occur whenever one of the many dies used for that type is slightly different in design. Examples of such varieties are the 1909 Lincoln cent with a V.D.B. on the tails side (designer's initials, later removed) and the 1942 dime with the 2 struck over a 1 (the die was originally intended for use in 1941). Varieties often prove to be the rarest of coins, and can make a collection quite difficult to complete. For this reason some collectors do not consider them a necessary part of the usual coin display. Indeed, many varieties exist which go uncollected by anybody—the whim of the collector controls their popularity.

Finding all the varieties, mint marks, and dates necessary to complete a series is a long tedious process. While they are waiting to fill those last few holes, numismatists improve their collections by a second method—upgrading, the replacing of a coin with a similar one of better condition.

The spectrum of coin conditions ranges from fair, a coin worn smooth with the date barely visible, to proof, a coin struck under perfect conditions and showing all detail in high relief. Proofs are struck especially for collectors by the Philadelphia mint only. The most desirable specimens available from a branch mint are of the next lower grade, that of uncirculated.

To be uncirculated, a coin must still meet stringent qualifications. Its features are exactly as they were when the coin left the mint. None of the high spots show a trace of wear. Once a coin has been dumped from the bank wrapper into a cash register drawer and then handed to a customer, it invariably becomes slightly worn and is no longer uncirculated. Another requirement of recent uncirculated coins is that they be as shiny as they were when they left the mint. Carelessly handled and unprotected coins become fingerprinted and tarnished. The fact that a coin cannot be uncirculated once it has been handed to the customer is what interests the investor. He knows that once the year has passed no more uncirculated coins of that date will be available except from people like himself who have intentionally kept them out of circulation. This is the hinge on which speculation swings.

The collector is constantly striving to place uncirculated specimens in his collection, and is usually willing to pay a premium (sometimes surprisingly high) for these coins. At the same time new collectors are always popping up and old ones are starting new collections. Choice specimens are constantly being lost through accidents and careless handling. The result—there are never enough shiny new coins to go around and the demand creates a natural situation for investment.

Arrows point to location of mint marks on modern day coins.

Example of a cent variety occurring in 1960. The cent on the right has a slightly smaller date—a very subtle difference, but one that has caused chaos in the ranks of collectors and investors.

The investor's stock requires a certain amount of coins, and thus he creates his own false demand. A good example of this phenomenon in action is the 1952 Denver nickel. During the first half of 1959 an uncirculated roll of these sold for about $15. During the fall and winter of 1959 investors suddenly realized that, while there were plenty for collectors just then, there were not enough for each investor to have as many rolls as he would like to put away. Immediately the price of a roll jumped to $80, a purely speculative price that would never exist were it not for false demand created by the trading among investors themselves.

The two techniques used in acquiring rolls of uncirculated coins, buying directly from a bank and buying from another investor or dealer, have already been lightly mentioned. The first is of course the most desirable since no premium is involved, and disregarding inflation one's investment can never drop below what has been sunk into it.

It is helpful to know a teller or have a merchant friend who banks every day and can keep on the lookout for uncirculated coins. When these coins appear in a certain denomination, they will be wrapped together with no old coins mixed in the rolls. But very few banks get new coins in all denominations. Fewer yet get coins from both mints.

(Continued on page 36)

What would *YOU* do as an engineer

Development testing of liquid hydrogen-fueled rockets is carried out in specially built test stands like this at Pratt & Whitney Aircraft's Florida Research and Development Center. Every phase of an experimental engine test may be controlled by engineers from a remote blockhouse (inset), with closed-circuit television providing a means for visual observation.

ratt & Whitney Aircraft?

egardless of your specialty, you would work in a vorable engineering atmosphere.

ack in 1925, when Pratt & Whitney Aircraft was esigning and developing the first of its family of istory-making powerplants, an attitude was born—a cognition that *engineering excellence* was the key success.

hat attitude, that recognition of the prime impor- nce of technical superiority is still predominant at &WA today.

he field, of course, is broader now, the challenge reater. No longer are the company's requirements onfined to graduates with degrees in mechanical nd aeronautical engineering. Pratt & Whitney Air- raft today is concerned with the development of ll forms of flight propulsion systems for the aero- pace medium—air breathing, rocket, nuclear and ther advanced types. Some are entirely new in oncept. To carry out analytical, design, experimental r materials engineering assignments, men with egrees in mechanical, aeronautical, electrical, chem- al and nuclear engineering are needed, along ith those holding degrees in physics, chemistry nd metallurgy.

pecifically, what would *you* do?—*your own engi- eering talent* provides the best answer. And Pratt Whitney Aircraft provides the atmosphere in which at talent can flourish.

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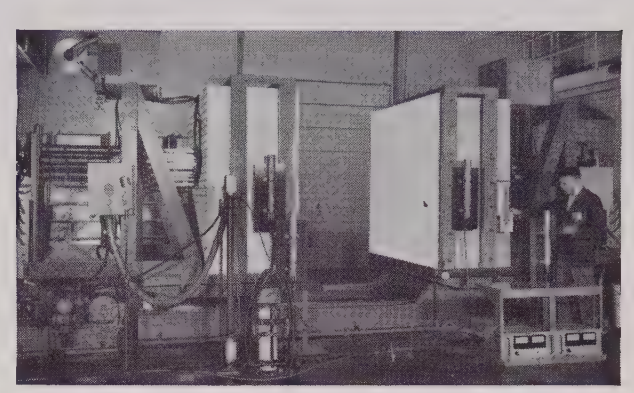
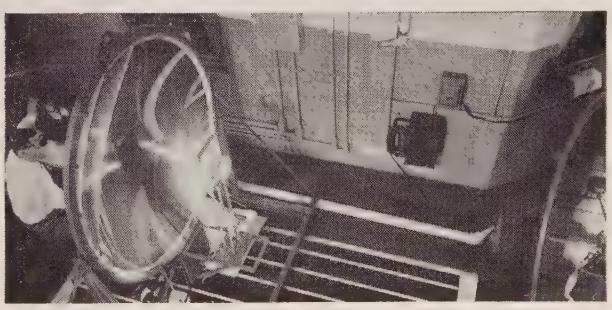
or further information regarding an engineering reer at Pratt & Whitney Aircraft, consult your col- ge placement officer or write to Mr. R. P. Azinger, ngineering Department, Pratt & Whitney Aircraft, ast Hartford 8, Connecticut.



At P&WA's Connecticut Aircraft Nuclear Engine Laboratory (CANEL) many technical talents are focused on the development of nuclear propulsion systems for future air and space vehicles. With this live mock-up of a reactor, nuclear scientists and engineers can determine critical mass, material reactivity coefficients, control effectiveness and other reactor parameters.

Representative of electronic aids functioning for P&WA engineers is this on-site data recording center which can provide automatically recorded and computed data simultaneously with the testing of an engine. This equipment is capable of recording 1,200 different values per second.



Studies of solar energy collection and liquid and vapor power cycles typify P&WA's research in advanced space auxiliary power systems. Analytical and Experimental Engineers work together in such programs to establish and test basic concepts.

PRATT & WHITNEY AIRCRAFT

Division of United Aircraft Corporation

CONNECTICUT OPERATIONS — East Hartford

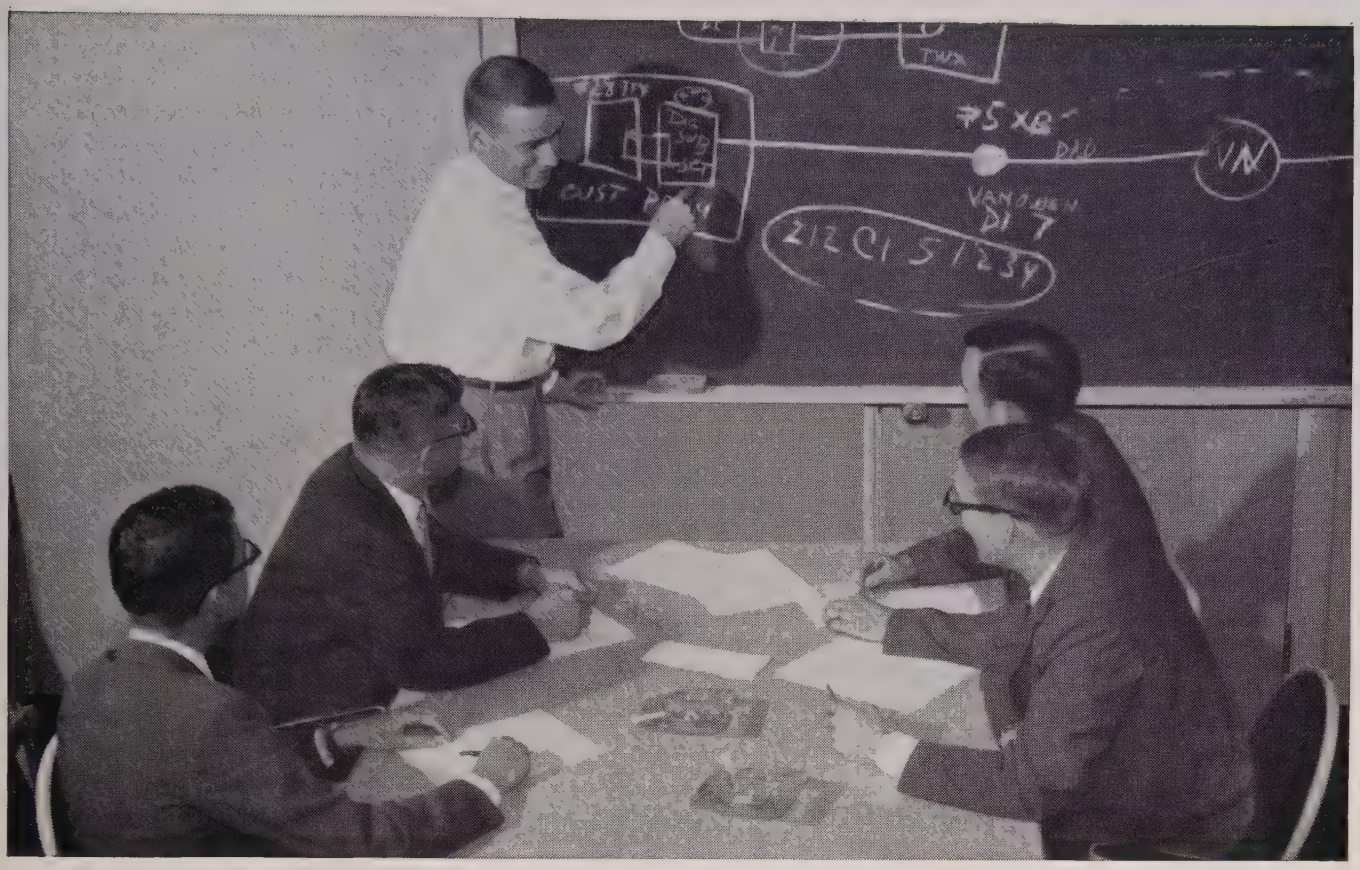
FLORIDA RESEARCH AND DEVELOPMENT CENTER — Palm Beach County, Florida

Technocutie . . .

WENDY JANE HORN

Our Technocutie this month is beautiful Wendy Jane Horn, the type of girl that engineers dream about. She calls LaGrange, Illinois her home, specifically Indian Head Park. She was born on a Halloween and has seen eighteen of these very special days. Wendy is a sophomore enrolled in Elementary Education, and we might just mention that she has a five point all University average. Wendy has a long list of favorites. According to reliable sources, she likes to read and play the piano. The Union Tavern, snow-ball fights, and baked potatoes smothered in butter also rate high on her list. Her pet peeve is finding people who have never heard of Indian Head Park. Wendy is planning to go into teaching unless some young engineer can change her mind.

Wendy Jane measures 34-22-34 in the right places as the photographs will attest. She stands a full 5 feet 3 inches tall. The fact that she has no brothers and sisters is well compensated for by twenty-nine cousins. If we tell you that Wendy is a pledge of Alpha Chi Omega, we are sure you engineers will find a way to get in touch with her.



STU'S EXPLAINING HOW MACHINES WILL SOME DAY "OUTTALK" PEOPLE

"Stu" Smith graduated from Southern Cal with a powerful yen for excitement. His kind of excitement—Engineering.

He got what he bargained for (and a little more) when he joined Pacific Telephone. One of Stu's early assignments was to find out how existing Long Distance networks could be used to pipeline high speed "conversations" between computers in distant cities.

The fact that he did a fine job did not go unnoticed.

Today, four years after starting his telephone career, Senior Engineer Stuart Smith heads a staff of people responsible for telegraph and data transmission engineering in the huge Los Angeles area. As a pioneer in this new data transmission field Stu predicts data processing machines will some day do more Long Distance "talking" than people.

Stu contacted 12 other companies before joining Pacific Telephone. "I don't think there's any limit to where a man can go in the telephone business today. Of course, this isn't the place for a guy looking for a soft touch. A man gets all the opportunity he can handle right from the start. He's limited only by how well and how fast he can cut it."

If Stu's talking about the kind of opportunity you're looking for, just visit your Placement Office for literature and additional information.

"Our number one aim is to have in all management jobs the most vital, intelligent, positive and imaginative men we can possibly find."

FREDERICK R. KAPPEL, *President*
American Telephone & Telegraph Co.

BELL TELEPHONE COMPANIES

THERMOELECTRICITY . . .

(Continued from page 13)

will be able to construct generators with over-all efficiency of 20 per cent, an efficiency level at which there would be many important applications for thermoelectric generators operating in the 1000-kilowatt range.

Projected Applications

In addition to certain military applications of thermoelectric generators which are expected to materialize, there are commercial applications that appear feasible in the near future. One of these is a thermoelectric power supply for communication and instrumentation equipment at locations along natural gas transmission lines in the many regions of the country where pipe lines and power lines are widely separated. Another similar application is thermoelectric power supplies for cathodic protection of oil well and pipeline equipment. Power requirements for such applications range from several watts to about 100 watts and are well within the capacity of today's technology.

Applications involving larger power levels will, of course, depend on an increase in the efficiency of thermoelectric power generation, but it is possible now to visualize thermoelectric power supplies in which a nuclear - reactor - energized thermoelectric generator included within the pile but equipped with external cooling loops would approach an over-all efficiency of 20 per cent for ratings in the megawatt range.

Major problems lie before us, of course, before such applications are practical but we are confident that thermoelectricity will be a very important element of the technology of the 1960's. We expect to be successful in our efforts to develop materials with efficiencies of 30 per cent or better and to design generators capable of giving us over-all efficiencies of at least 20 per cent. Equally important, we are confident too that we will soon have perfected the manufacturing methods that are necessary for the economical production of large-surface thermoelectric elements in quantity.

In a Nutshell

Latest advancement in the race to shrink precision servo-motor gearheads for space-and-weight savings is the tiny "size five" unit. The new unit, only one-half inch in diameter, is the world's smallest transmission. A dwarfed descendant of the familiar automobile transmission, the miniature, precision gearhead produces ratios up to 2,025-to-1, and is machined in tolerances far more exacting than those of a fine watch.

A Word About . . .

AERONAUTICAL ENGINEERING

at the

UNIVERSITY OF ILLINOIS

Today, in the age of high speed aircraft, ballistic missiles, and space vehicles, the Aeronautical Engineer is more and more in demand. The student who elects aeronautical engineering as a career has a challenging opportunity ahead; that of contributing to man's conquest of sky and space. In all probability, one of the first men to travel into space will be aeronautical engineer.

The main branches of aeronautical engineering are aerodynamics, structures, propulsion, and design. However, the rapid advances of the field have introduced many new branches which formerly belonged solely to the realm of the theoretical physicist. Among these are orbital and celestial mechanics, magnetohydro- and gas-dynamics, as well as phases of kinetic theory, atomics, and nucleonics.

Aeronautical engineering requires a strong background in mathematics and physics. The first two years of the curriculum emphasize these subjects, but also include such courses as manufacturing processes, modern history or political science, and the basic freshman courses common to all engineering curricula. Beginning in the third year, the student gets his introductory course in aero, a course in aerodynamics of perfect fluids which gives the student the basic theory of fluid flow, thin airfoils and finite wings. Mathematics to or including advanced calculus is prerequisite for this course. At the same time, courses such as thermodynamics, mechanics of materials, and electrical and metallurgical engineering are taken.

As the student advances, he receives training in aircraft structures, aerodynamics and thermodynamics of compressible and viscous fluids, aircraft propulsion, and airplane and space vehicle design, as well as laboratory courses in these subjects. The student may also elect courses in rocket propulsion, orbital mechanics, or advanced aerodynamics, among others. By the time the aeronautical engineer finishes his training, he is well equipped to enter this rapidly advancing profession, whether it be in research, development, teaching, or what have you.

However, the function of the Aeronautical Engineering Department does not end with the education of undergraduate engineers. A great deal of research is also being carried out by the department on the graduate level. Many projects are being done by graduate students as one of the requirements for an advanced degree. Other projects are carried out by faculty and staff and are sponsored by the department or the Engineering Experiment Station. Still others are sponsored by the government or by private industry.

Among the research being done in the department are a study of high strength shock phenomena, using the Mach 20 shock tubes constructed by the department and studies of the aerodynamics of gliders and delta wings. Also being undertaken is the development of the Tesla Turbine, which operates by friction of gas on flat discs instead of using the conventional turbine blades, thereby greatly reducing weight, complexity, and costs and at the same time making possible operation at higher temperatures than possible with the conventional gas turbine.

Work is also being done to develop a hypersonic wind tunnel to simulate reentry conditions for ballistic missiles and space vehicles. The source of power for the wind tunnel is a high-intensity electric arc which heats the air to temperatures of more than 1½ times that of the sun's surface.

The student who undertakes graduate work in aeronautical engineering has a chance to work on a project of his own, as well as a chance to work on one of the departmental projects as a graduate research assistant. He also is able to choose his courses to emphasize the branch of aeronautical engineering which interests him most, to a far greater extent than is possible in undergraduate work.

In all, the future of the student in aeronautical engineering is very bright, with endless opportunities open to him in this rapidly advancing profession.

Winter

by John Ernest, I. E. '64

(The following is included to disprove the old idea that engineers cannot write. This is a good example of the themes that many freshman write; read one man's concept of what winter should be. Ed.)

As I drove to school that brisk day in January of 1959, I could sense that Decatur was due for a change of weather. Huge black clouds roamed the darkened sky, and the temperature was dropping steadily. The wind was beginning to sway the trees, and small whirlwinds scurried about. The weather seemed to be building to a climax, which would be reached at any moment.

By noon, not only had the temperature dropped to eight degrees above zero, but the wind had reached a speed of fifty miles per hour. An hour later, Decatur was in the midst of a drenching rain. This rain, combined with below freezing temperatures and gale-like winds, produced a violent storm. Ice was everywhere, and soon power lines began to snap because of the force of the wind and the weight of the ice that covered them.

At one-thirty, school was dismissed because of power failures. I am usually overjoyed to get out of school early, but on this particular day I was not too eager to step out into the blinding storm. Finally, I gathered enough courage to dash to my car; but, when I reached the car, I was enraged to find that the doors were frozen shut. After several attempts, I managed to pry open a door with a metal bar. I then started the car and drove toward the parking lot exit.

Driving conditions were terrible. The streets were extremely slick and visibility was very poor. Cars were stalled along every street and live power lines were dangling from bent over poles. I drove toward home very slowly, but when my car stalled on a hill, I was forced to travel the remainder of the way on foot.

Walking in this weather was even more difficult than driving in it. I was completely covered with ice, and with the wind blowing toward me it took a considerable amount of effort to trudge onward. Finally, I arrived at home where I changed into dry clothing. That night when I went to bed, the wind was still hurling the freezing rain against everything in its path.

The next day the storm had ceased, but the temperature was still below freezing. Thus, everything in sight was incased by ice, which provided a majestic appearance to buildings and trees. Although the storm had created a very beautiful scene, it had also caused much work for most of the following people: lineman, tow truck operators, doctors and nurses, street workers and policemen.

Although, I usually enjoy wintry weather, I hope that I am never forced to encounter a storm similar to the one of 1959. When I think of wintry weather, I like to imagine fluffy white snowflakes gently descending upon an already whitened terrain; not of freezing rain causing physical conditions to be miserable.

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Housing Boom

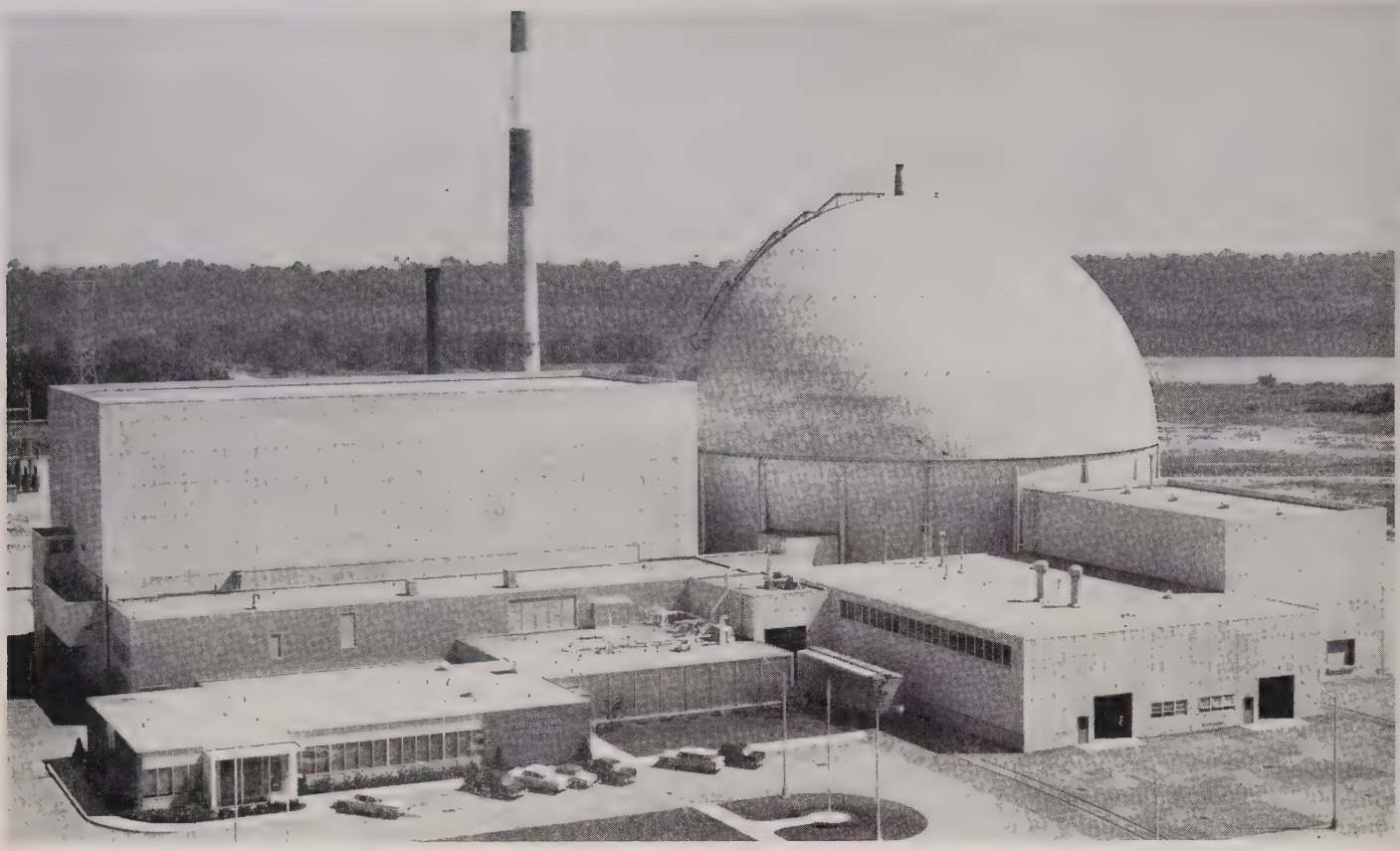
A Florida home developer is using dynamite to blow earth together instead of apart. By setting off sizable blasts 20 feet down in light, sandy soil, the developer is packing the sand hard enough to support the weight of homes he plans to build.

World Adopts New Standard Of Length

The world adopted a new international standard of length—a wavelength of light—replacing the meter bar which has served as the standard for over seventy years. The new definition of the meter as 1,650,763.73 wavelengths of the orange-red line of krypton 86 will replace the platinum-iridium meter bar which has been kept at Paris as an international standard for length since 1889 under the Treaty of the Meter.

Music from Below

The subterranean music from the famed "Stalacpipe" organ deep in the Caverns of Luray, Va., is getting a scientific touch as small threaded rods of Allegheny Ludlum Steel Corporation's AL-4750 alloy steel are bolted rigidly through the ancient stalactite "pipes" of the instrument. After the stalactites have been struck by rubber-tipped hammers, the alloy bolts vibrate with the rock, close to tiny wire-wound magnets.



—Photo courtesy of Commonwealth Edison

Nuclear Power and Its Applactions—Part II

Electricity from the Atom

by George Carruthers, Aero. Eng. '61

When uranium or plutonium fissions in a nuclear reactor, most of the energy given off eventually appears as heat. Therefore, any device which produces electricity from nuclear energy works on the same principles as those using more conventional power sources—the main difference being that, in the case of the nuclear power devices, the heat source is almost inexhaustible.

In the first article of the series, it was shown that the major parts of any nuclear reactor are (1) fuel, (2) moderator, (3) reflector, (4) coolant, (5) shielding, and (6) control mechanisms. It is in the coolant that lies the means of extracting heat from the nuclear reactor, as it is shown in thermodynamics that no power can be extracted unless there is a temperature difference between two points.

There are two main types of methods for extracting power from a nuclear reactor or from a heat-emitting radioisotope. These are the direct methods and the indirect methods. In the indirect methods, a coolant is passed through the reactor and is heated to a high temperature. This coolant, which is made radioactive due to bombardment by reactor neutrons, is pumped to a heat exchanger where it gives up its heat to a secondary coolant, which is not radioactive. The secondary coolant is turned into a high-pressure vapor in the heat exchanger, and then is used to drive a turbine which, in turn, drives an electric generator. Therefore, the net effect is to replace a conventional coal-burning boiler with a nuclear reactor and its primary coolant loop. (See Fig. 1.)

In the direct methods, the reactor heat is converted directly into electricity without the need of complex, inefficient, and heavy heat-exchanging devices, turbines, generators, etc. which are necessary in the indirect methods. The main types of direct methods are (1) thermoelectric, (2) thermionic, and (3) magnetohydrodynamic.

All of the large-scale nuclear powerplants under construction or in use in the United States today are of the indirect type. The indirect methods of power conversion are classified according to the type of primary coolant and the type of reactor used to generate the power. Some of the main types are (1) boiling-water reactor (BWR), (2) pressurized reactor (PWR), (3) liquid-metal coolant reactor, (4) organic-cooled and moderated reactor, and (5) gas-cooled reactor. Reactors also can be classified as either homogeneous or heterogeneous types; in the former, the fuel and moderator are mixed together, whereas in the latter the fuel is formed into elements which are placed into spaces in the moderator. Homogeneous reactors can have either solid or liquid cores; in the latter, the fuel-moderator mixture can serve as its own primary coolant (see Fig. 2).

Perhaps the best example of the boiling-water type of reactor system is the

Dresden Nuclear Power Station of the Commonwealth-Edison Company, located 50 miles southwest of Chicago, which went into full-power operation June 29, 1960. The plant, built at a total cost of over $51,000,000, is the first privately financed, full-scale nuclear power plant to go into operation in the United States. The 180,000-kilowatt plant is also the largest operating nuclear power station in the world. Its output is sufficient to serve a city of 200,000 people.

The power source for Dresden it the General Electric dual-cycle boiling water reactor, an advanced design of the single cycle boiling water reactor developed by Argonne National Laboratory.

Water is boiled by fission heat inside the reactor core and produces steam at 545°F. The boiling water rises through large pipes to a huge steam drum where water and steam are separated. Primary steam is piped to the turbine-generator at a pressure of 1000 psi.

The hot water separated from the steam flows down through four secondary steaam generators which produce additional steama at 500 psi. This secondary steam flows to the turbine for admission at a lower stage.

The reactor contains 65 tons of nuclear fuel, consisting of uranium which is slightly enriched so that it contains slightly more than twice the U-235 of natural uranium. Dresden's first core loading fuel is valued at $15,000,000 including fabrication expense. The initial loading, which is expected to last 3½ years, will produce as much electricity as 2,000,000 tons of coal. Although the plant does not produce electricity as cheaply as a conventional station, it serves as a stepping stone toward the development of nuclear power plants which will operate on a cost level comptitive with plants burning conventional fuels.

An example of a pressurized-water reactor power station is the one at Shippingport, Pennsylvania, which will have an ultimate power output of 150,000 KW.

In a pressurized-water reactor, the primary coolant water is held at a very high pressure so that it cannot boil, even at temperatures approaching 600°F. This superheated water is pumped through a heat exchanger, where it boils secondary water which in turn drives the turbogenerators.

A portable pressurized-water reactor power plant is scheduled for delivery at McMurdo Sound in Antarctica, in 1962. A plant of this type already is in operation at a U.S. base near Thule, Greenland.

The liquid-metal cooled reactor has several advantages over the water cooled types in that liquid metals, such as sodium or lithium, have excellent heat

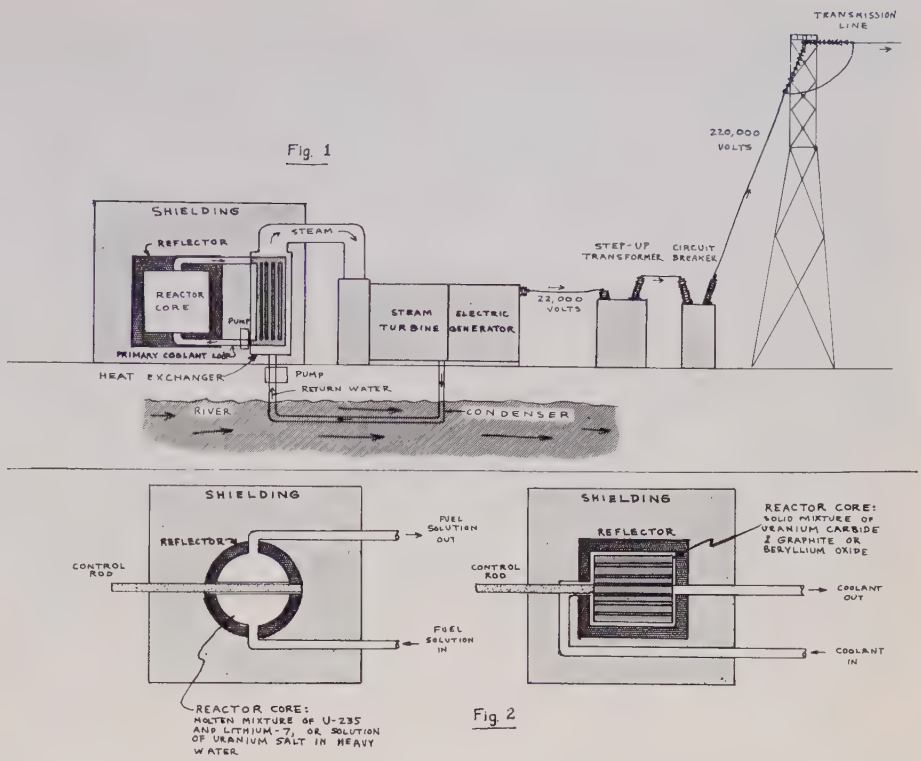


Fig. 1—(Top) Conversion of nuclear power to electricity.

Fig. 2—(Left) Liquid core reactor using uranium and a moderator in fluid. (Right) Solid core reactor employing ceramic, cermet, or alloy of uranium and a moderator.

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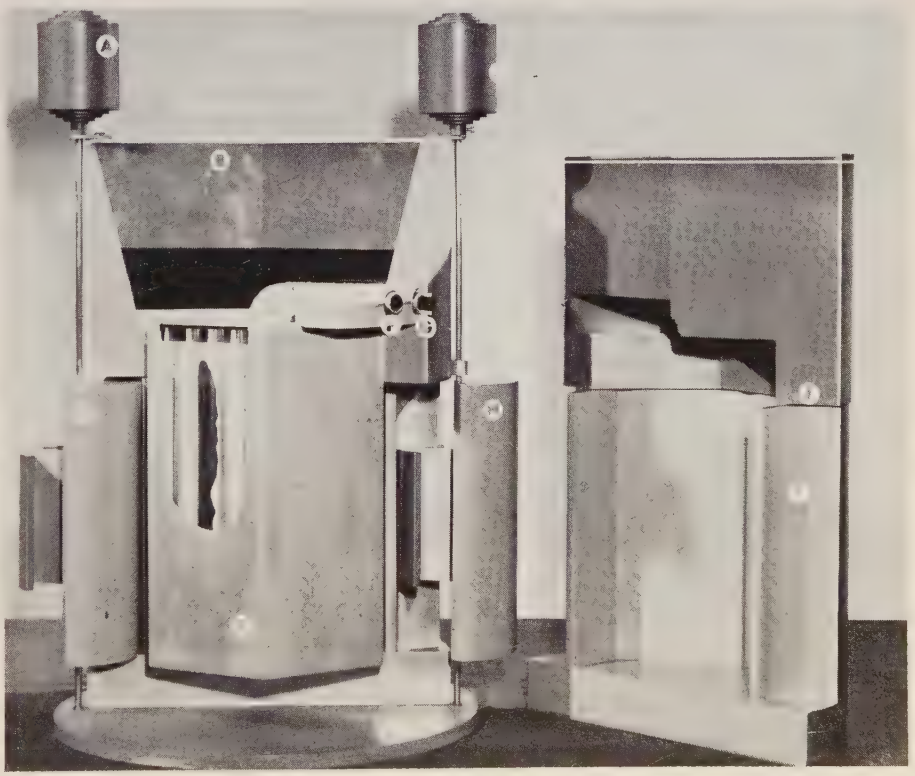


Fig. 3—Full scale model of a reactor similar to the Snap Experimental Reactor. In an operational SNAP II device, heat from the reactor would be transferred by a liquid sodium coolant to a boiler containing mercury, which, in turn, drives a turbine. Photo courtesy A.E.C.

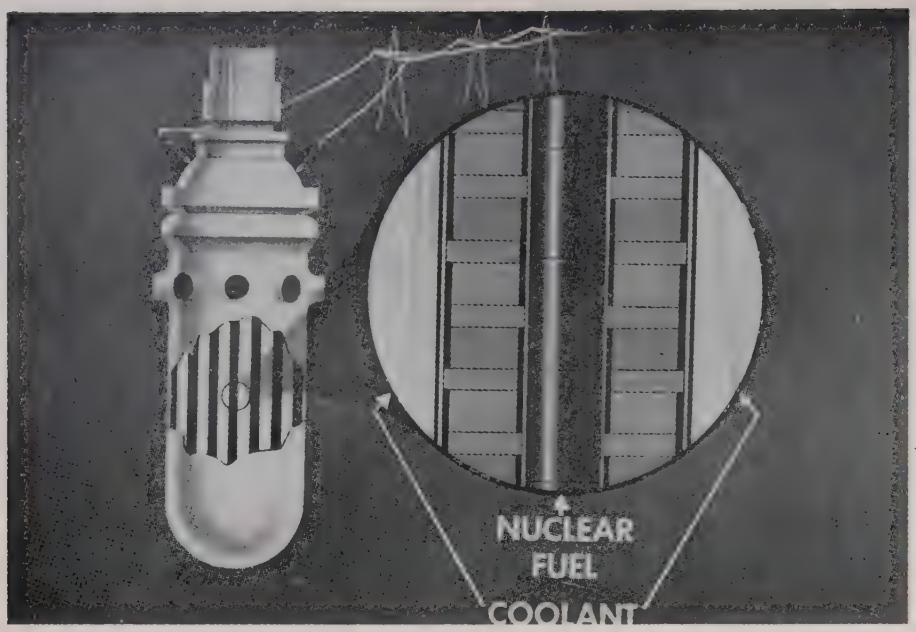
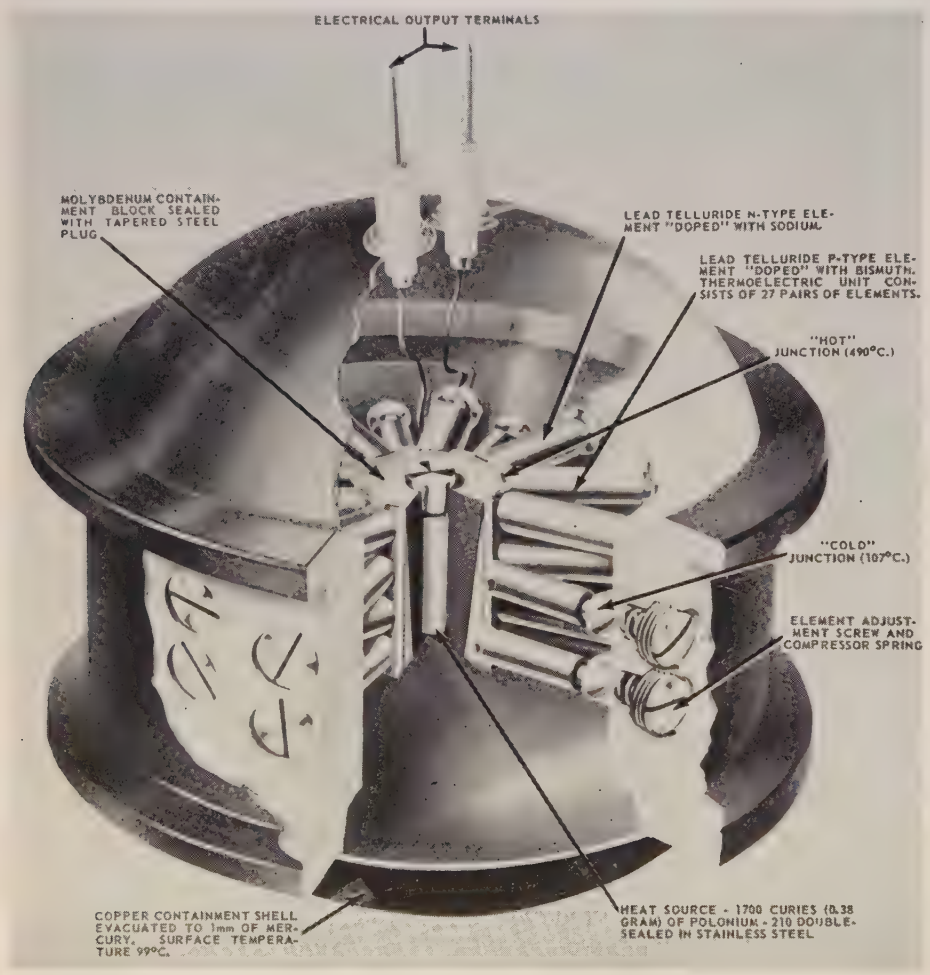


Fig. 4—Direct type thermoelectric generator. Heat from fission converted directly to electrical energy.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"COLD" JUNCTION (107°C.)
ELEMENT ADJUSTMENT SCREW AND COMPRESSOR SPRING
COPPER CONTAINMENT SHELL EVACUATED TO 1mm OF MERCURY. SURFACE TEMPERATURE 99°C.
HEAT SOURCE - 1700 CURIES (0.38 GRAM) OF POLONIUM - 210 DOUBLE-SEALED IN STAINLESS STEEL

Fig. 5—Artist's concept of SNAP III generator.

conductivity and heat-transfer properties which make them ideal for removing heat from reactor cores. However, due to the fact that these substances are corrosive at high temperatures, and react violently with air or water, only experimental reactors of this type have been built, although the first civilian sodium-cooled reactor power station is scheduled for operation in 1962.

The Atomic Energy Commission has developed a 3-KW, 600-lb. sodium-cooled reactor, with mercury as the secondary coolant, for use in power generation in space vehicle systems. Known as SNAP-II (Systems for Nuclear Auxiliary Power), the device uses movable segments of the neutron reflector to control the chain reaction instead of control rods. See Fig. 3.)

The organic-cooled and the gas-cooled reactors are still in the experimental stage, although each looks promising for future uses. The pebble-bed reactor, an example of the latter, uses small balls of uranium-graphite or uranium-Beryllium oxide mixture loaded into a hopper and cooled with helium gas. The LAMPRE (Los Alamos Molten Plutonium Reactor Experiment) is an attempt also will be made to use the primary coolant directly for running a turbogenerator. The U.S. Army is developing a mobile 300-KW gas-cooled nuclear power plant weighing only 15 tons complete with shielding.

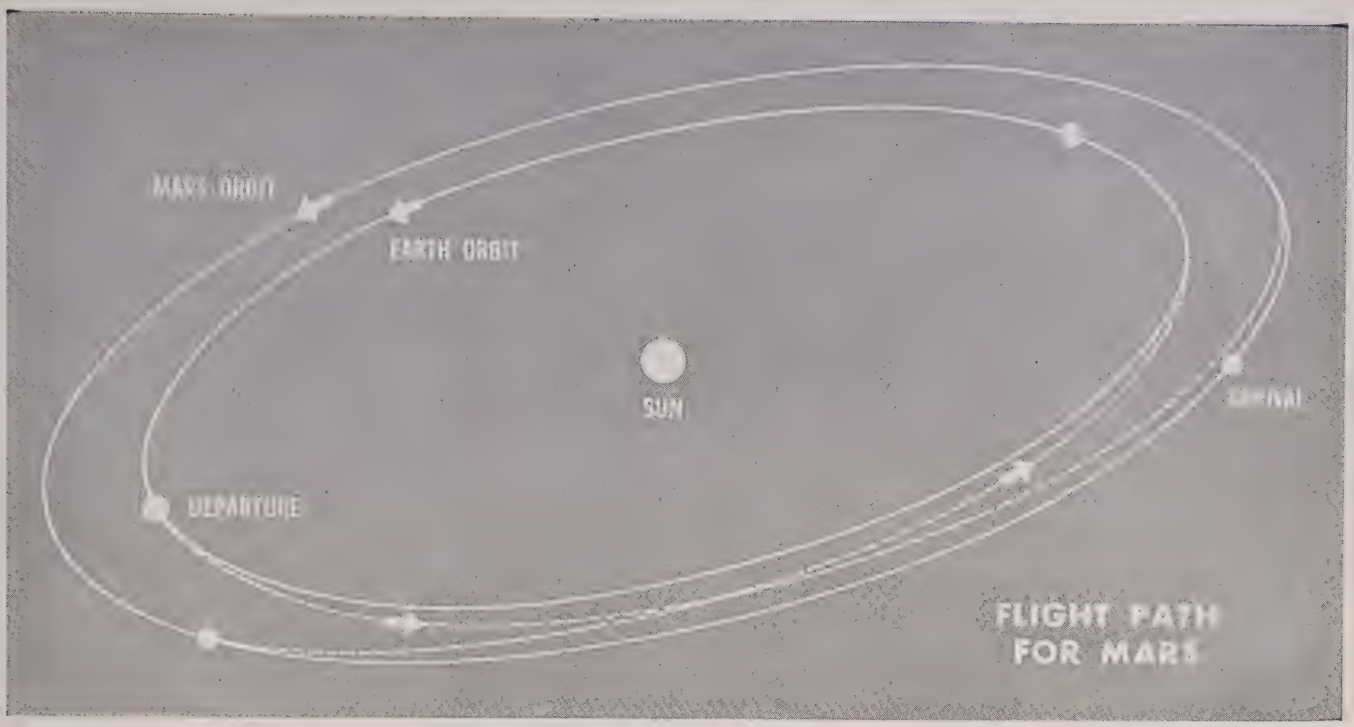
The direct-conversion devices offer great advantages over the indirect devices because of their inherently lighter weight, a greater simplicity, and potentially greater efficiency. This makes them especially suited for auxiliary power sources in aircraft and space vehicles, and it is in this connection that their development has been pursued.

The thermoelectric devices work on the principle of the thermocouple, in which a temperature difference between two joints of dissimilar metals sets up an electric potential. A device using thermoelectric conversion would have one junction of each thermoelectric element (the "hot" junction) in contact with the reactor fuel element or radioisotope container, and the other ("cold") junction in contact with the reactor coolant or a heat-radiating surface (see Fig. 4).

The "SNAP-III" device, developed by the Atomic Energy Commission, uses Polonium-210 as the heat source, and generates five watts of power for nearly a year. In the course of this time, the five-lb. device generates as much electricity as 1450 pounds of the best conventional batteries. (See Fig. 5).

The thermionic devices work on the same principle as does the filament of an ordinary vacuum tube: a metallic surface when heated to very high temperatures will emit electrons. If a cold collecting plate is placed nearby, electrons will strike it and will bet up a voltage on the plate with respect to the emitting surface. If, as in an ordinary vacuum tube, the space between the emitter and plate is evacuated, the maximum power output is limited to a very low value by a phenomenon known as *space charge*. In space charge, the emitted electrons tend to hang around the emitting surface instead of moving to the plate, and, due to their net negative charge, tend to discourage other elec-

(Continued on page 40)



new areas of interest enhance careers for engineers and scientists at Hamilton Standard

HAMILTON STANDARD DIVISION of United Aircraft Corporation has long been a dynamic force in the aircraft equipment field . . . with an unmatched record of stability and accomplishment. Typical of Hamilton Standard's achievements are environmental conditioning systems which are standard equipment on such aircraft as the 1400 mph Convair B-58 Hustler Bomber. Fast moving advances in space technology, however, pose new problems . . . new challenges.

TO MEET THESE CHALLENGES Hamilton Standard is conducting advanced research and development on environmental control problems for manned space vehicles. The Moon Room pictured at right was specifically designed to assist engineers and scientists in identifying and analyzing the practical problems involved in CO_2 regeneration. However, within such sealed experimental chambers studies can be conducted to develop means of removing or regenerating body heat, water vapor, nitrogen and other contaminants given off by man in a space vehicle. Several possibilities exist for effecting each phase of control in an environmental control system. For example, CO_2 can be removed by the freeze-out method, chemical absorption, physical adsorption and diffusion or filtration of molecules. Consideration of the space envelope and the weight of equipment must be made. In the case of CO_2 this involves heat exchangers, regenerators, water separators, blowers, valves and vents. Need for secondary electrical power supplies to operate equipment creates additional problems.

OBVIOUSLY, UNDERTAKINGS of this nature involve the utilization of a wide variety of engineering and scientific fields of study providing intellectual growth and career satisfaction.

MOON ROOM—Leo Foxwell, BSME Wisconsin '53, right, enters the Moon Room with analyzer as Sid Russell, BS Chem. Rutgers '52, checks CO_2 control. These young men, who are in the Advanced Product Planning Group, have played a major role in actually designing and developing the equipment and test programs for this undertaking.

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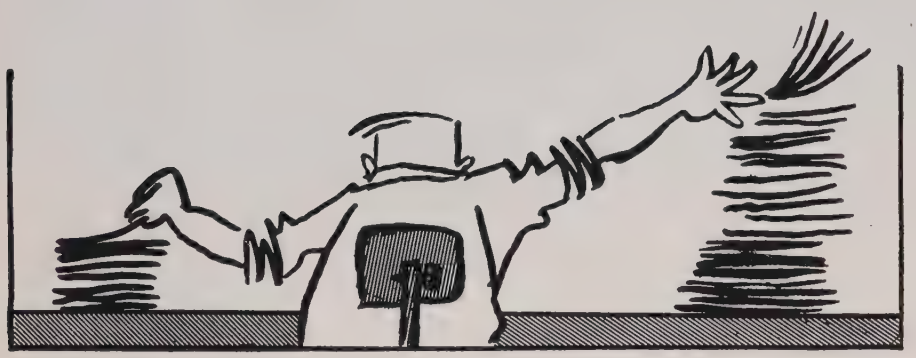
Skimming Industrial Headlines



Edited by Wally Cwik

Construction Balloon

A military contractor in Wyoming encloses work areas with a nylon balloon to keep his construction crews working on the worst winter days. The inflated balloon measures 100 by 60 by 30 feet, and includes a 12 by 12 by 25 foot air lock for truck entry and a small personnel air lock. A one-and-a-half horsepower fan supplies air to keep the balloon inflated.

Slipcover for Bridge

Steel trusses will replace New Jersey's last covered bridge—the 88-year-old Green Sergeant's Bridge in Hunterdon County—this summer, but they will be discreetly veiled. Wooden wall and a shingle roof will fit over the new span, to mollify tradition-minded residents of the area. Builders hope to get most of the wood for the disguise from the remains of the razed bridge.

'Lid' for Lakes

The U. S. Bureau of Reclamation is trying to devise a gigantic "lid" it can use to halt water loss through evaporation from artificial lakes and reservoirs in the western U. S. It has poured some 200 compounds on test lakes so far, and has found that cetyl and steryl alcohol work best in thinly coating surfaces, sealing the water in.

Jet-Propelled Dirt

The Russians claim the development of the "first Soviet jet earth-digging machine," with capacity of 4,000 tons per hour. The Russians say the blast from a jet engine is used to remove rock to a depth of six feet over a strip six-feet wide and throw it up to 100 feet away.

Inventors! Don't Give Up!

The government finds that 40 out of every 1000 proposals submitted by inventors as solutions to its publicized research problems have some merit, ten of the 40 ideas are worth testing, and about 2½ of the ten are finally adopted.

Keeping Cool Head

An air-conditioning unit that can be worn over the head has been devised. It consists of a fiber glass helmet and face plate connected to a portable, electrically-powered refrigeration system. The system provides a flow of cool air over the head and shoulders.

Ancient Helmets Updated

A replica of the ancient visored and crested Roman helmet has found its place in the Navy's jet carrier age. The helmets contain radios that enable deck personnel to communicate over the roar of jets. The visor contains a microphone and the antenna is in the crest.

PROFITS . . .

(Continued from page 23)

Smaller towns where banks have less turnover of coin may get uncirculated pennies only, and often get no new coins at all. Banks that have a good local source of coin such as from parking meters and vending machines seldom get new coins.

There are several ways around this problem. One is to have a friend (in parts of the country where needed coins are more likely to be found) stockpile rolls until there are enough to make an express shipment worthwhile. Vacations are often planned to the proper area so that express charges can be avoided. Many friendships exist to satisfy this very function, usually on a reciprocal basis.

At times all sources seem to fail. In this case there are two choices of action: pass up the rolls needed or buy them from another investor or a dealer who specializes in selling rolls. There are pros and cons for each of these choices.

For the very reason that one person may not be able to acquire a certain denomination, date, and mint roll, many others may not be able to also. This causes low supply in that particular issue and thus makes it a better investment.

The reasonable dealer will be asking only thirty to eighty cents premium on an uncirculated roll of the current year, although there are exceptions where some unusual situation has caused excess speculation on a certain issue. But paying a premium for rolls is a new plunge in this type investment. It usually makes profits, but if prices should drop it will create dispiriting financial losses.

If making the plunge, deciding whether the premium is worth paying or not is the investor's problem. There is no exact set of rules for such a decision, but some of the points generally considered follow. Most of these pointers apply equally well to nonpremium investments when there is a large choice of them available.

Choosing The Investment

Beware of paying high premiums for apparently scarce coins of the current year. Often about the middle of the year, the mintage (number minted) of a particular issue will be lower than usual for that time of the year. This causes many investors to get excited and the premium on that particular coin soars. Such a price increase draws more investors into the picture who believe "there must really be something here—look at the way other investors are buying." This causes even higher prices because of increased demand, and a vicious circle is formed. Suddenly about September the mint makes more of the particu-

lar coin and prices plunge downward even faster than they went up. This very thing happened during 1960 when the number of Philadelphia nickels minted was a comparatively low two million. The roll price of these nickels had worked its way to $12.50 by August when the Philadelphia mint started minting more than a million nickels a day, sending their roll price crashing downward to $2.75. Needless to say, thousands of investors lost many thousands of dollars.

Usually low mintage issues, which are the reason for the soaring price phenomenon discussed above, are good investment issues if the total minted stays low. Whenever the *total* number is less than normal the issue becomes scarce and draws a higher premium. Actually low total mintage figures are surprisingly high. Sixty million pennies, fifteen million nickels or dimes, two million quarters or halves are mintages plenty low enough to cause chaos in the ranks of investors.

But low mintage issues are not the only ones that develop short supply, and hence good returns for the investor. Occasionally a common high mintage issue will slip by the investors with relatively few investing in it. While there are plenty of circulated specimens of that particular coin available, uncirculated specimens are comparatively rare. An example of this would be the before mentioned 1952 Denver nickels of which thirty million were made, but whose price is $80 per roll uncirculated. Another, the 1949 Philadelphia half dollar sells for $280 per uncirculated roll, yet the 1948 half dollar with about half the mintage of its 1949 counterpart sells for only $50 per roll. Because of just such quirks the investor tries to cover as broad an area as possible with his investment. Many investors try to put away at least one roll of each denomination and mint each year (known as a roll set), after which they begin to put away extra rolls of whatever appears to have high investment potential.

Penny, nickel, and dime rolls are more frequently the choice for investments made after roll set completion. There are two reasons for this, the first being that these three are more widely collected than quarters and half dollars and thus have a higher intrinsic demand. The second is that to the collector, a coin is a coin, and its face value has nothing to do with its worth to his collection. The premium on a half dollar is therefore no more, and is in fact less apt to reach a certain value than is the premium of a penny. The investor is more likely to make a $10 profit on a roll of pennies than he is on a roll of halves, yet his investment is so much less on the pennies. Of course this policy may backfire if collectors find there have not been enough quarters and halves saved to fill the collections that exist. Should this be the case, supply will be short, demand will go up, and with it the prices.

The remaining two points to be discussed concerning investment choices are first year issues and varieties. Let it suffice to say that the first year of a new type or design coin is seldom a good investment, the cause for this being that the interest of many people is stirred by the new design and they save that year. But many lose interest after the first year, creating a comparative surplus of the coin. The exception to this rule would be first year issues that have very low mintages.

Varieties are an item of true speculation, since most of them are comparatively rare, but many go neglected and unprofitable. Others, however, catch on and become listed in the popular reference books, causing their value to multiply rapidly for a while. A few of the 1955 Philadelphia cents were struck from a die that had been double engraved, causing a double image of everything on the heads side of the coin. When this coin was first listed in a popular reference book in 1959 its value (uncirculated) went from $15 to $60. An uncirculated roll of them would now be worth at least $3500! (And only six years old!)

A 1960 variety, the small date cent, issued from both Philadelphia and Denver mints has caused great excitement already, even before any listing in the reference books. On those cents issued early in the year the dates ore actually smaller in size than dates on the later cents. Denver smalls first sold for $5.00 per roll and the Philadelphias for $200, but in another example of how one should be wary of high premiums, Denver smalls now sell for only $3.25 and Philadelphias have dropped to $75 per uncirculated roll.

No one can deny, however, that this is a nice juicy and fast profit that many Americans, from housewife to executive, have been able to cash in on by merely being on their toes while at the local bank. But the investor does not usually want to sell his entire stock of such a good issue, nor in ordinary cases does he have the opportunity to sell for a worthwhile profit until several years have passed. In the time lapse that occurs between procurement and sale, rolls must be preserved with the upmost care if the original mint luster of the coin is to be preserved, and with it the highest resale prices.

Preservation of Uncirculated Rolls

Copper, nickel. and silver are all very susceptible to chemical discoloration. Coins that are left in the paper wrapper in which they came from the bank will not stay brilliant. Both oxygen in the air and sulphur in the paper will cause the shiny surfaces to tarnish, and there is no way to regain the original mint luster once it has been lost. Plastic tubes and sulphur-free paper are just two of the many things sold for packaging uncirculated coins so they will not tarnish. The preference of most investors, however, is the old standby, tin foil, or in these modern days. aluminum foil. Foil is inexpensive and highly effective in keeping unwanted elements away from the coins. Paper bank wrappers must be removed before rewrapping the roll in foil. During this process care must be exercised not to touch the coins with fingers or any object which will leave tarnishing chemical deposits. The collector wants shiny, clean coins for his collection, not fingerprints or other marks of the coin's previous owners. Except in cases where the coin is scarce in all conditions, the premium of it with such discolorations is little or nothing.

Once his coins are protected from the elements, the investor's problem is to find a place where, what is often quite a bulk of coin, can be stored. There are of course innumerable such places, and only a few will be mentioned. Perhaps the most common is at the back of a closet shelf, or in a corner of the attic. Some people have been known to bury their rolls, just as plantation owners did with their gold in days of the Old South, but a more common place is the steel filing cabinet. For rolls that represent a large investment, one of the best places is a safe deposit box at the bank. A box large enough to hold 150 to 200 rolls rents for about $6 per year.

Few people are lucky enough to have a safe in the home in which to keep coins, but an almost equal place found in many American homes is the deep-freeze. Most deepfreezes have locks on them, are an unlikely place for prowlers to look, and offer a good chance of survival for coins in case of fire. Fires, incidently, have been the undoing of many uncirculated roll investments in the past, for inevitably the heat is so severe that it causes discoloration, and often pitting of the coin's surfaces.

One old fellow put his coins in glass jars and had solid concrete porch steps poured about them. That was in 1925. Last year he had to do without steps for a couple of days while a laborer broke up the concrete and poured new ones. It was well worth the old man's trouble. Included in those coins were ten pieces of each coin minted at Philadelphia in 1921 which he had bought for a small premium in 1925. Those fifty coins alone netted him $3500 in 1959!

How did the old man decide when to sell his coins? Without a personal interview from him, it would be extremely

(Continued on next page)

DAWN — *Science Fiction*

by Ruth Keil

(Here is a short one for all you Science Fiction lovers.—Ed.)

The telephone. He felt into the darkness and haphazardly found the receiver.

"You forget, Claude, that I have to sleep," he said. "My mind is not immortal. Now disconnect the communication wires and I'll come see you first thing in the morning."

Claude's reply was bitingly impatient. "You also forget, Mel, that some of my observations must be given to you at night, for you can't see the stars in the daytime, as I can. You will come to see me in five minutes."

All right, play the game called "humor the immortal," thought Mel sourly as the bang at the other end pierced his sleepiness. But this is the last time I'll be slave to your whims, government or no government.

Five minutes later Mel pushed open the heavy metal door and groped his way into the midnight of the observation room. A screen on one wall flashed into focus and Mel could see the moon. Bored, he stood in front of the picture and looked at the craters. As one of the hand-picked candidates, he had practically memorized all the known landscape of this new frontier. He wondered idly why Claude had awakened him merely to show him this.

As if in answer to his question, Claude's voice on the loudspeaker cut through Mel's thoughts.

"I know that you harbor grudges against my superior intellect and judgment; it can't be helped. If you remember, you were one of those who voted that my mind be saved when my body died in the accident. You must listen now to my instructions. You are the only one who will share my latest solution to the inhabitation problem of the moon."

"Do enlighten me," Mel replied sarcastically. "You know that our present project is to get someone up there first, before we think about pioneers and homesteaders. Since I'm a candidate for the first pilgrimage, I'd like to know what you're cooking up now."

"Patience, Mel; bear with me and keep your mind open. First I must give you some history in order that you understand what you are going to do. I've been experimenting with the science of teleportation."

Mel's laugh interrupted Claude. "Shouldn't you say art, rather than science, old boy?"

Instead of becoming angry, Claude replied musingly, "That is an interesting question, Mel. You alone are going to find out the answer for me."

Mel was unaccustomed to the smooth tone of Claude's voice. For months he had heard nothing but an irritable tolerance. Now Claude sounded patient and almost friendly. A vague warning bell rang in Mel's subconscious.

"Rockets take too long, Mel. And they aren't as safe as I would like them to be. I've been exercising and strengthening my mind, just between you and me, I can send rabbits anywhere!"

"Claude, I'm not going to be your next rabbit," Mel cut in wildly. "I'll take the rocket. Thanks anyway for the suggestion," he added as he turned toward the door.

Too late. Mel was on his way to the moon.

PROFITS . . .

(Continued from page 37)

hard to say, for there are probably as many theories about when to sell as there are investors. Some say sell when the roll has doubled value; others say tripled, quadrupled, or more. Some sell half their investment in a particular group of rolls every time it doubles in value. Some hold all they have until they need the cash, and often leave fabulous estates for their heirs.

If a stable market is to remain for uncirculated rolls, the decision of when to sell must be made by each individual investor, and not be regulated by some coverall rule that would cause many people to sell at one time. Such a rule would obviously bring disaster to the market when the time came to sell. The one aid that all active investors use in getting both market information and potential buyers is the trade journal, of which there are many in the coin business. The great boom in coin investments can be seen on their pages. There is page after page of advertisement—rolls wanted, rolls for sale plus single coins for collectors. One newspaper has more than doubled size and distribution in the last year. A listing of some of the better known publications follows:

The Numismatist, for information write Lewis M. Reagan, General Secretary, P.O. Box 577, Wichita, Kansas, (official publication of the American Numismatic Association).

The Numismatic Scrapbook Magazine, Hewitt Brothers, 7320, Milwaukee Avenue, Chicago 31, Illinois.

Coin World, Sidney News Building, Sidney, Ohio.

Numismatic News, Iola, Wisconsin.

The Coin Collector, 300 Booth St., Anamosa, Iowa.

Coin Press Magazine, 231 N. 18th St., East Orange, New Jersey.

Nearly every town has a newstand that carries one of these publications. To accompany these periodicals, a reference book of United States coins is invaluable. While such a book is more collector-directed than the periodicals, it still has a wealth of general information about coins that helps the investor better understand them and the people who collect them. The most popular of these books are:

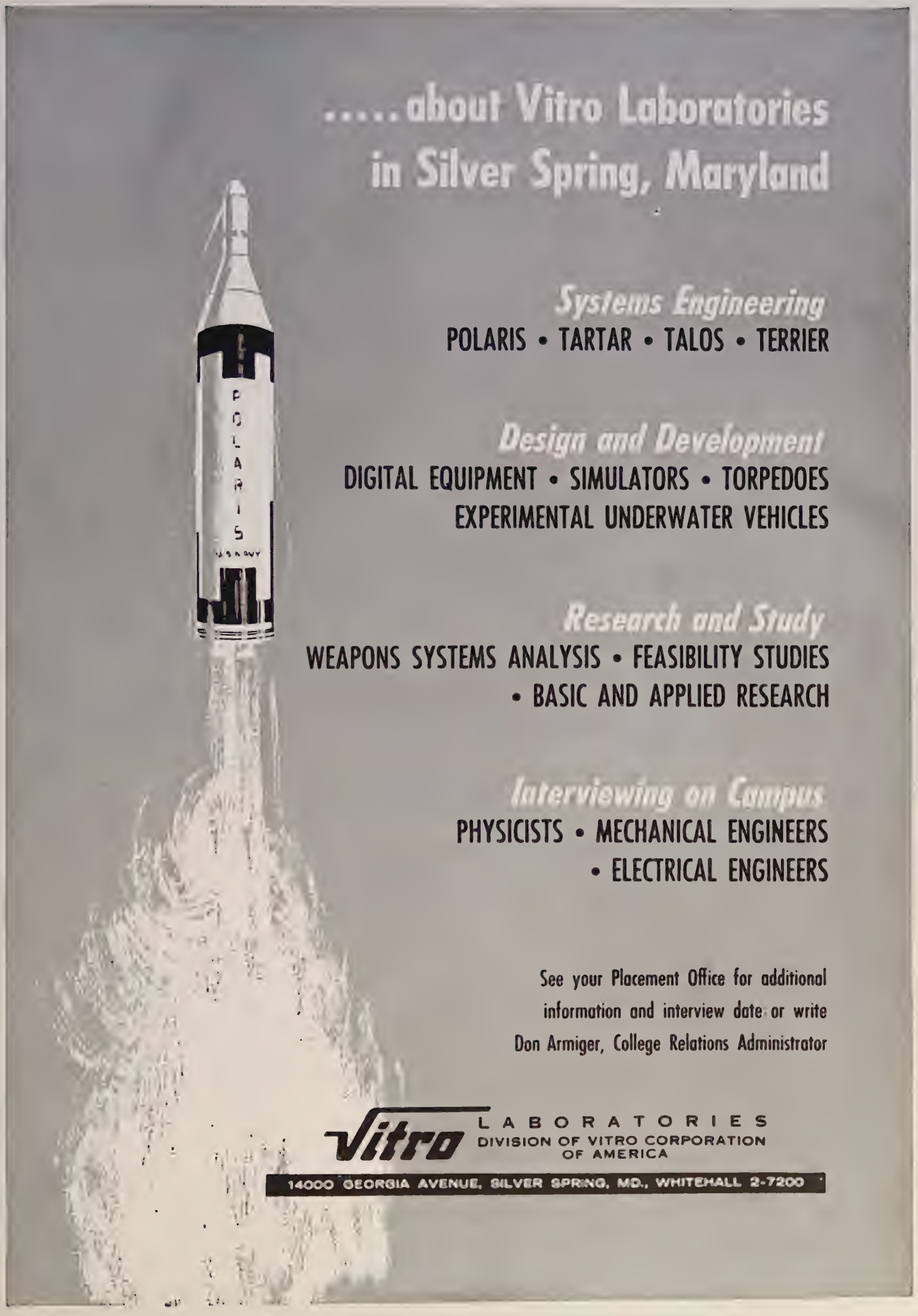
A Guide Book of United States Coins, R. S. Yeoman, Whitman Publishing Company, Racine, Wisconsin. ($1.75, published every year, general information and dealer's retail prices).

Handbook of United States Coins, R. S. Yeoman, Whitman Publishing Company, Racine, Wisconsin. ($1.00, published each year, general information and dealer's average buying prices).

For the investor, periodicals have a definite advantage over reference books since they are able to keep up with the constantly changing roll market. Reference books list only prices for single coins, and have a chance to change these listings only once a year.

This might all be called a plan for easy speculation. If nothing else, it is surely a plan for scientific saving. A penny in that uncirculated roll is always worth a penny, and in years to come may be worth a great deal more. Low risk, ease with which it can be done, and small amounts of capital required are the keys to the success of modern day uncirculated coin speculation.

In the course of it all, these coins are not just profit-making tools. They are entertaining and relaxing. They allow whoever wishes to play the market to do so, just as the Wall Street financiers do. They lead many to the pleasures of coin collecting. Making profits with your money becomes as much fun as a hobby!



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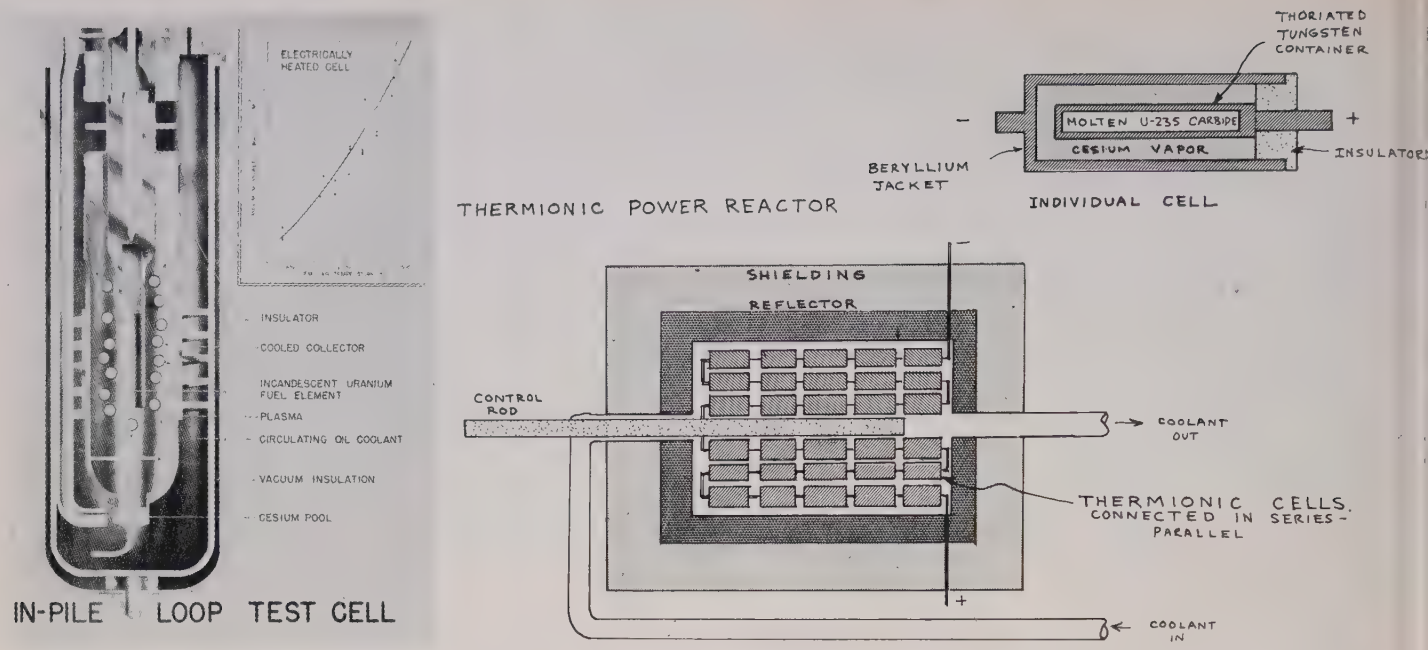


Fig. 6 (Left) Los Alamos plasma thermocouple. (Right) Thermionic power reactor using plasma thermocouple cells.

NUCLEAR ELECTRICITY . . .

(Continued from page 34)

trons from being emitted from the heated surface.

If, instead of having a total vacuum in the space between the emitter (cathode) and the plate (anode) we introduce a very small amount of an easily ionized substance such as cesium, positive ions are formed which neutralize the negative electronic space charge, making possible a much greater current from cathode to plate.

This is the principle of the plasma thermocouple (also known as plasma diode or thermionic diode) which has been recently developed by scientists at Los Alamos Scientific Laboratory. (See Fig. 6.) When the device, which is about the size of an empty frozen lemonade can, is placed in an atomic reactor, the central rod (composed of a mixture of uranium-235 and zirconium carbides) becomes white hot due to reactor-neutron induced fission of the uranium, and emits electrons which are collected by the water-cooled container. The device has an output of 3.8 volts and a short-circuit current of 30-40 ampers. Obviously, the implications to future atomic energy developments are enormous.

In Fig. 6 is shown a possible thermocouple power supply in which the central fuel elements themselves form the critical mass and the containers, which are constructed of beryllium, form the moderator.

The magnetohydrodynamic device, which probably is best suited for large scale applications, utilizes a magnetic field to separate the ions and electrons in an ionized gas or plasma (See Illinois Technograph, October 1960). In this type of power conversion, the nuclear reactor has an advantage over chemical combustion in that the gas that is used can be selected without regard to its combustion characteristics, and therefore substances with much betteer ionization properties than combustion gases (for example, pure potassium vapor) can be used as the working fluid (See Fig. 7). The MHD device is probably the simplest of all the power conversion devices, having only a magnet and two electrodes per stage. Therefore, it would be ideally suited for a high-power-level portable nuclear power plant for use in Antarctica or on the moon. However, since the MHD device works most efficiently only at very high operating temperatures, there are many materials problems to be solved before the MHD device finds operational use.

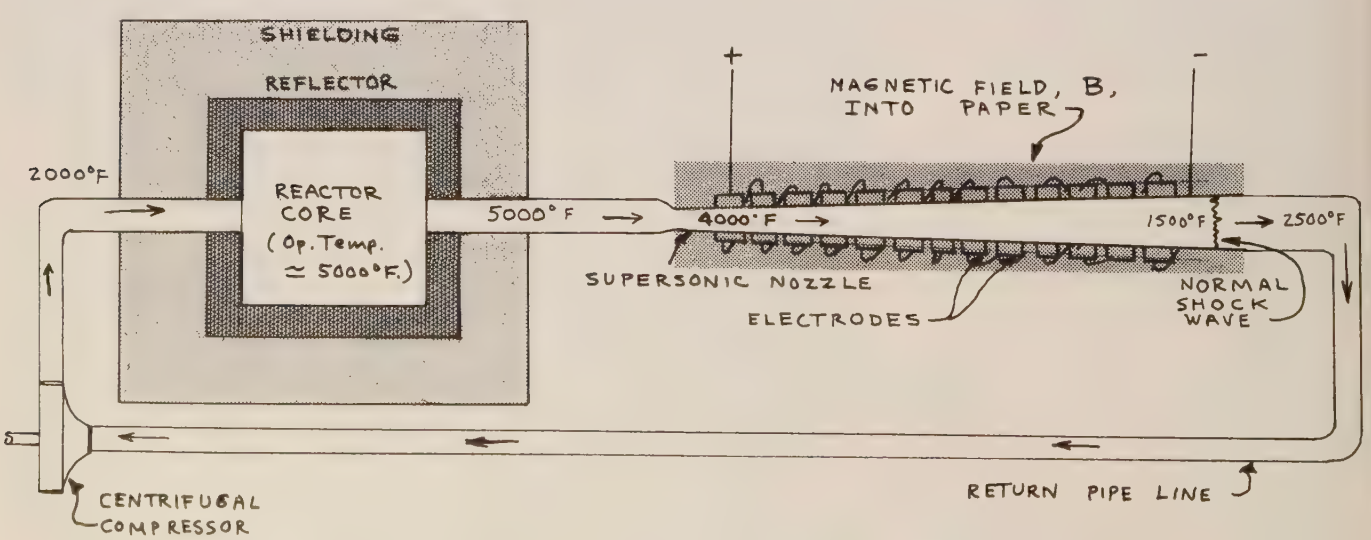
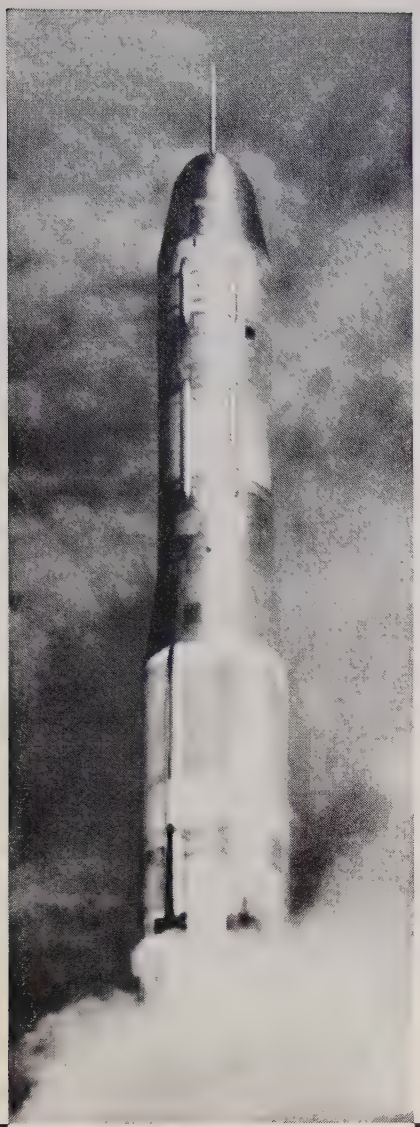


Fig. 7—MHD power generating station using nuclear reactor as heat source.



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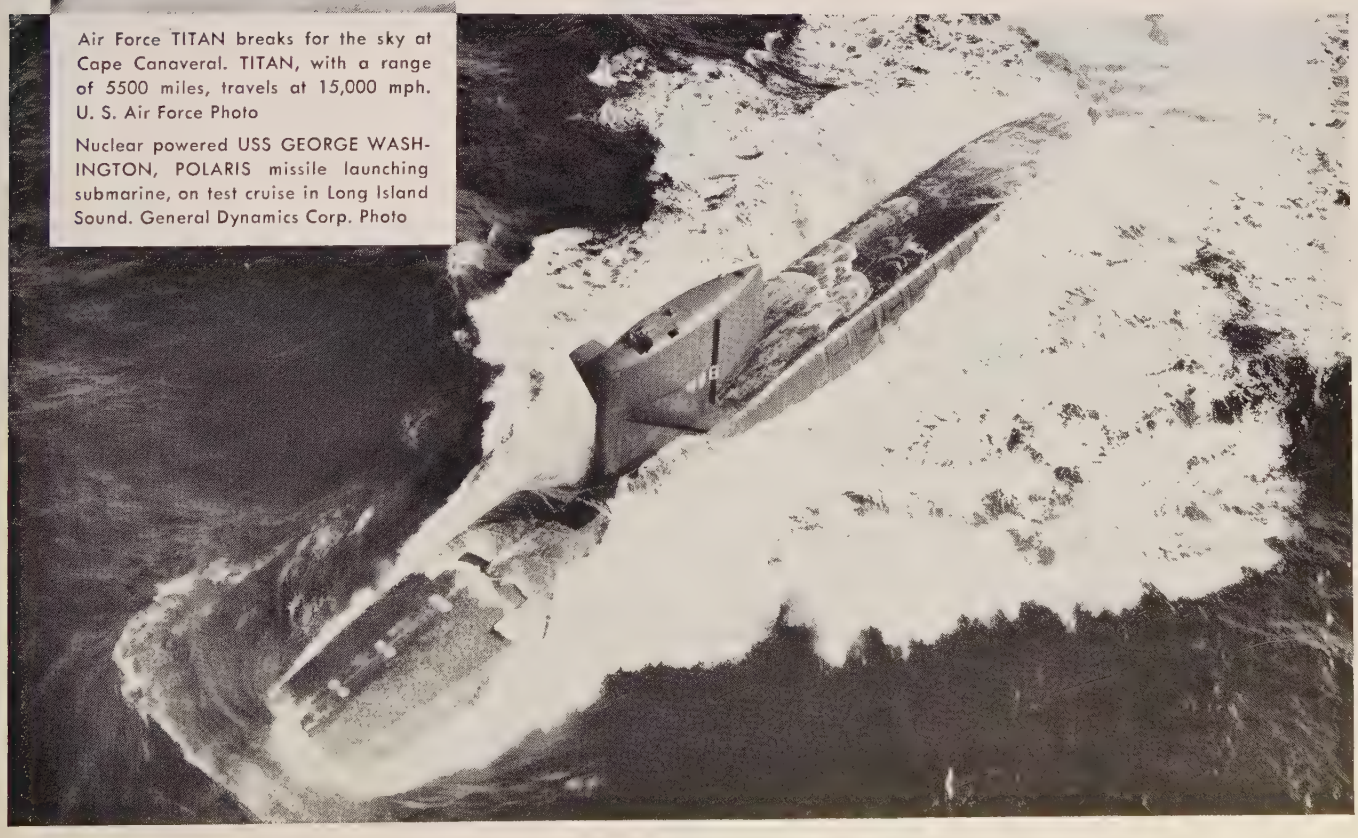
Air Force TITAN breaks for the sky at Cape Canaveral. TITAN, with a range of 5500 miles, travels at 15,000 mph. U. S. Air Force Photo

Nuclear powered USS GEORGE WASHINGTON, POLARIS missile launching submarine, on test cruise in Long Island Sound. General Dynamics Corp. Photo



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THE DIESEL ENGINE FOR AUTOMOBILE USE

by David E. Hartnett

A Diesel engine is a combustion engine in which the fuel is ignited by the heat of compression. More specifically, pure air is compressed until it reaches a temperature that will ignite the fuel being used. While compression ignition eliminates the need for separate ignition equipment and therefore simplifies the engine, it is really an incidental feature of the operating cycle. The chief reason for using high compression is that it increases the thermal efficiency of the engine; that is, it reduces the amount of fuel consumed per unit of work done. The use of his high compression is made possible by compressing air only, instead of a combustible mixture of air and vaporized fuel which would be ignited too early during the compression stroke. As the fuel is sprayed into the highly-heated air under great pressure it need not be as volatile as that required by carburetor-type engines, and Diesel fuels generally are considerably cheaper, gallon for gallon, than gasoline and similar volatile fuels. As stated before, fuel consumption (gallons per mile) is considerably less than for petrol engines.

The development of the diesel engine was hindered by the fact that the high compression necessary for its performance required a high degree of tolerance between piston and cylinder. This high tolerance was not possible during the pioneer days of the motor vehicle; hence the petrol engine developed earlier and has maintained its lead due to the economic demand of automobiles. In its early days the diesels were strictly slow speed, powerful engines which were generally very large. Another disadvantage the diesel had was that it had to be a much heavier engine since explosion pressures in the compression ignition system are much higher than in the petrol engine. Diesel engineers became accustomed to designing almost without regard to what in the automobile industry is known as weight efficiency.

However, Charles F. Kettering and the General Motors Research Laboratories developed a diesel which ran at higher speeds and was lighter in weight. This was done by innovating the two-cycle principle, in which every downstroke of the piston is a power stroke and thus an engine of the same size develops twice the power. It was really very simple; instead of letting the piston push the exhaust gas out, a blower was supplied to blow it out, and thereby reduced a stroke from the cycle.

Once the diesel had established itself as a competent high speed engine, its development increased rapidly. The most recent development of the diesel engine is the use of the hemispherical combustion chamber and improved rotary fuel pumps. Research work has led to an improvement in injection nozzles also. Despite the fact that development of the diesel engine lagged behind the development of the conventional automobile engine in its early days, it has already advanced to the point where it must be considered as competition to the gasoline automobile engine.There is no doubt that the diesel will replace the gasoline automobile engine at least in fields where there is a substantially constant demand for comparatively large amounts of power, and where the fuel cost therefore forms a considerable item in the total operating cost of the powerplant. This is notable in large fleets of trucks that must pull heavy loads and get a great deal of continuous use. The fact that the diesel burns a cheaper fuel constitutes an important advantage in competition with the gasoline engine. This will be discussed later.

It would be advisable to investigate the thermodynamic principles involved in the diesel and gasoline engine and see how the two compare in this respect. The diesel cycle provides combustion at constant pressure (theoretical) whereas the ordinary gasoline engine gives combustion at constant volume; its combustion takes place rapidly when the compressed air-fuel mixture is ignited by an electric spark. These two conditions of combustion are illustrated graphically by the accompanying indicator diagrams with their respective temperature = entropy diagrams. Comparison of the T-S diagrams indicates an important point. We all know that, according to the principle envolved in the Carnot Cycle, for maximum efficiency the energy should be delivered to the cycle at the highest possible temperature. It is evident therefore that the diesel engine is more efficient since it can deliver its energy at a higher temperature. The gasoline engine is inhibited in that its fuel ignites at a low temperature as compared to the ignition temperature of a diesel. This limits the compression ratio in the gasoline; otherwise, pre-ignition and knocking occur. But it is known that the higher the compression is the more efficient an engine becomes, and this gives the combustion ignition engine another big advantage. Only pure air, not gasoline and vapor, is compressed and there is nothing to pre-ignite since the diesel fuel injection is timed to take place when it is wanted and not before. Thus it is seen that the diesel has a distinct advantage in that it is capable of delivering thirty to thirty-eight per cent of its fuel heat value as compared to only twenty to twenty-five per cent for the gasoline engine.

Another good approach in comparing these two engines is analyzing their performance curves. These performance curves are for two 6-cylinder engines, one diesel and one gasoline, of exactly similar design. The gasoline engine gives greater power at high speeds, but the power and torque of the diesel are better at normal speeds while fuel consumption of the gasoline engine is more than double that of the diesel unit, especially at low and high speeds. Hence we see some important characteristics about diesel engines; it is apparently more efficient at the speed that automobiles are most frequently run. The present day automobiles work most of the time at only a fraction of their top power; they are driven mainly in the city and even when run on the highway are prohibited from maximum performance by speed laws. *(Continued on page 46)*

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Sikorsky Aircraft is the company which *pioneered* the modern helicopter. Our current program is far-ranging and is recognized as one of the broadest and most challenging in the entire aircraft industry.

Work associations are stimulating and in an atmosphere of progress. Assignments could include joining an *electronic* team of twenty to thirty associates—or—working with a highly selective group of four or five on interesting problems of *radiation, instrumentation, auto pilotage, automatic stabilization,* etc.

If you want to enter this *"stream-of-action"*, the time is *now*. Opportunities for personal progress have never been greater.

For detailed information about careers with us, please write to Mr. Richard L. Auten, Personnel Department.

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AUTOMOTIVE DIESEL . . .

(Continued from page 43)

The important fact to notice from the curves is that at the normal speeds (800—1200 RPM), the torque of the diesel engine is high compared to that of the gasoline engine. Torque may be described as a "capacity for turning" or good "pulling power." The diesel pulls well over all its speed range. It is "a good puller at low speeds" and is not easily stalled when the speed drops as does the gasoline engine. The current use of automatic transmissions is a factor which necessitates better torque characteristics at low speeds.

It was mentioned earlier that the diesel had a distinct advantage in that it can operate by using cheaper fuel. Recent developments in the refining industry have led to the trend to use better diesel fuel which is more adaptable to high speed characteristics. This fuel is more expensive than the diesel oil used at present but is still much cheaper than the high octane fuel required for present day automobiles. In addition, the fact that the diesel uses less fuel must not be forgotten. Another advantage in relation to fuel is that the exhaust of a diesel engine contains very little of the highly poisonous carbon monoxide gas found in the exhaust from the spark-ignited engine. Also, unconsumed fuels in the form of hydrogen and marsh gas are present in much greater proportion in the exhaust from spark-ignited engine.

To get a better outlook on the future of the diesel engine as related to automobile use, it is desirable to know what the trends in automobile manufacture are. Some of the trends in automobile manufactuer are shown graphically.

It is noticed in the first illustration that the trend has been to increase the weight or the size of the car. However, it should also be noticed that in the most recent years automobile weight has tended to stay constant. In the second illustration, it is made apparent that there has been an endeavor to decrease the weight of the engine as compared to its horsepower output. The tapering off at the bottom of the curve also indicates that automotive engineers are finding it increasingly difficult to improve this ratio. In the third illustration it is clearly shown that automotive engineers have also nearly reached a peak as to how much they can improve the compression ratio and consequently the horsepower, without introducing much more expensive fuels which are knock-free and have such a high octane ratings as to be on a level with aircraft engine fuel.

The diesel engine becomes more important as one sees the limitations of the automobile engine and yet unreal-

ized limitations of the diesel. The spark-ignition engine of the automobile has nearly reached its absolute peak thermal efficiency and this is still lower than that of the diesel. The trends also indicate that people are beginning to realize that it is senseless to own large fast moving automobiles when they seldom get use at peak performance.

Most of the credit for the pioneer work in the adaptation of the diesel engine to road vehicles must be given to Germany. The Mercedes-Benz, a 46hp diesel produced in Germany is now widely used in Europe and Canada. The Studebaker-Packard company started to handle these engines a few years in an effort to distribute them for use in taxi-cabs. A considerable number of Mercedes-Benz taxi-cabs are being used in New York and they have proved very satisfactory. The fact that these engines are only 46hp as compared to the 150hp of some current automoiles should not be misleading. Maximum horsepower is not as important as "usable" horsepower at normal operating conditions. The superiority of the diesel's torque curve in the low end of the engine's speed range (where most city driving is done) provides ample torque for nimbleness in traffic. These taxi-cabs have been getting 26 miles per gallon as compared to nine to twelve miles per gallon for other taxi-cabs. The cab companies have been paying nineteen cents per gallon for their fuel.

The most recent development in the diesel for the private car has been the Perkins "Four 99" manufactured in the United States. It is a 4 cylinder, 320 pound engine capable of 43hp at 4000 rpm; it has a top speed of 80 miles per hour, and when run at 56 miles per hour for two straight days it used 37 miles per gallon.

An indication that others think that high-speed diesel engines are going to be used extensively is the fact that Chrysler Corporation included in its fold on June 1959 the Deutz Company which is scheduled to start producing 60,000 high speed engines per year.

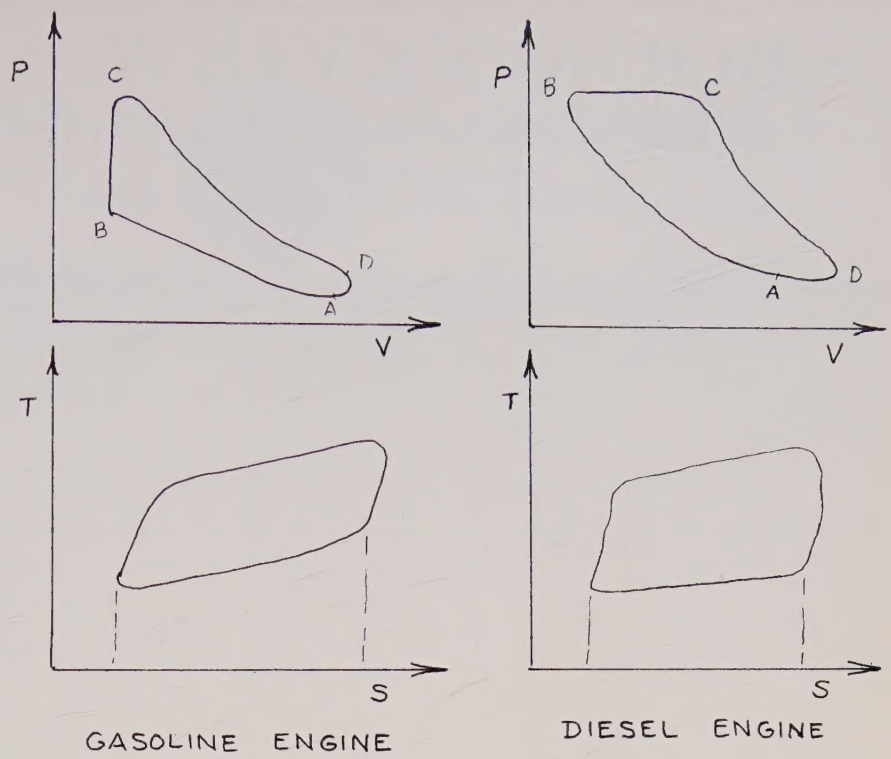
Housewife Special

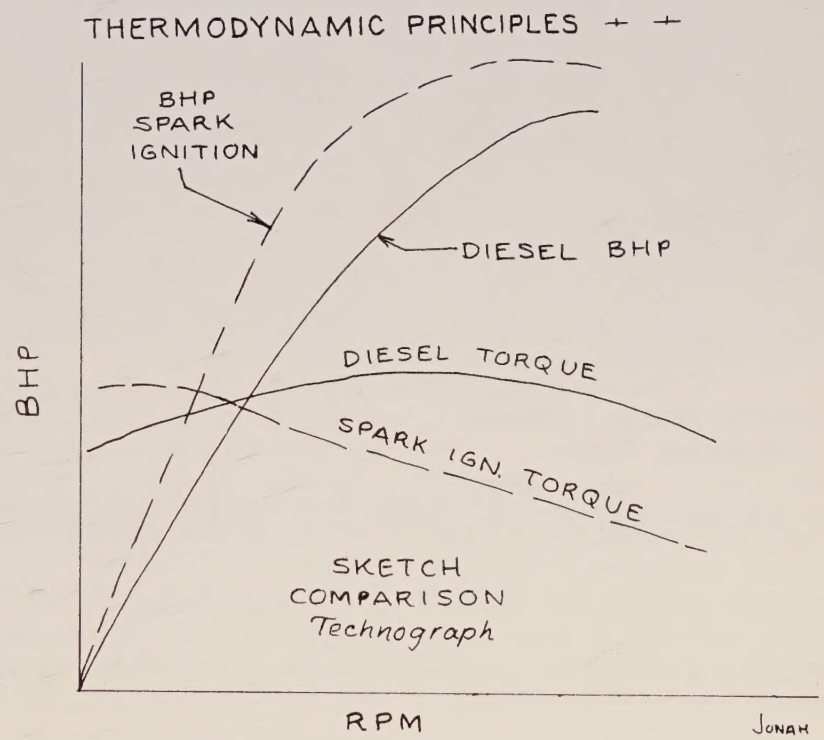
An electric car for the housewife doing neighborhood chores has been built by a Detroit laboratory. Designed for short-distance travel, the car weighs 447 pounds, is 24 inches high and has a one-third horsepower motor for each rear wheel. Top speed is 15 to 20 miles an hour. Its batteries require recharging every two hours.

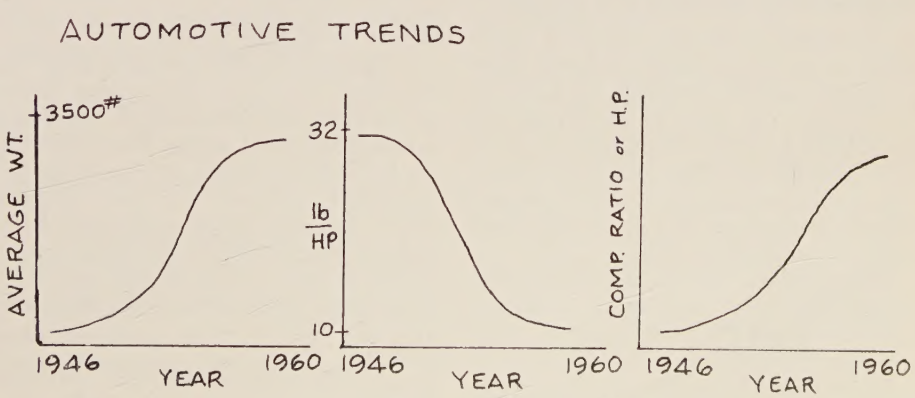
A small boy's head bobbed up over the garden wall and a meek little voice said, "Please, Miss Brown, may I have my arrow?"

"Certainly, where is it?"

"I think it's stuck in your cat."







BOOK REVIEW

CARE AND REPAIR OF YOUR SPORTS CAR
By oCee Ritch
144 Pages, Cloth Bound, Arco Publishing Company, $2.75

The parking problems here on campus and in many cities throughout the nation have been solved by bus-riders and partially compensated for by the sports car owners, but the special little vehicles have created problems of their own. Most mechanics just do not know how to fix them. For the engineers and others who have been confronted by this maintenance trouble we offer the following solution—a quick "cure" for sports car problems (without selling the car).

A new and highly illustrated guidebook offers money saving repair tips for all sports car owners at the do-it-yourself level. It separates basic repair work from the type that should be done by a specialist and provides an excellent guide for buyers of used sports cars.

Top professionals offer tips on tune-up; maintenance on overhead cam engines; a key to good driving habits; a detailed analysis of ignition systems; and what to look for in planning a check-up of a newly purchased sports car.

The author, oCee Ritch, qualifies as an expert because of his own lengthy experience in competition and in repair shops. Yet, he calls on other professionals to aid him in the preparation of this most practical repair book.

"Care And Repair Of Your Sports Car" is cloth bound and has 144 pages of photos, facts, and easy to follow maintenance advice.

It is available at most book stores or may be purchased directly from Arco Publishing Co., Inc., 480 Lexington Avenue, New York 17, N. Y.

First 'Gallop' Poll

An argument about the horse's gallop led to the first high-speed photographs. In 1872, to win a bet that all four hooves left the ground for an instant during a horse's stride, Eadweard Muybridge lined up 24 wet-plate cameras with a separate trip wire to each shutter. A horse galloping past hit the wires, tripped the shutters and produced a series of bet-winning pictures.

All-Welded Trusses Fabricated For Engineering Center

Three 50-foot, 20-ton all-welded trusses will support the library roof in the new United Engineering Center now under construction in New York. Murex electrodes, supplied by Metal & Thermit Corporation, were used in the fabrication of the giant sections. More than 1000 feet of weld was required per truss.

High-Energy Electric Arc Heater

A machine with the potential capability to supply a stream of gas at temperatures as high as 20,000 degrees F and pressures as great as 15,000 psi has been devised by the Westinghouse Electric Corporation. The machine, an electric arc heater, can operate for sustained periods of time and at an extremely low level of gas contamination.

Dr. John A. Hutcheson, vice president in charge of engineering for Westinghouse, said, "The temperature into the nozzle of the unit has been maintained at 10,000 degrees—approximately as hot as the surface of the sun. In addition flow from the nozzle of the unit has reached a sonic speed of 34,000 miles per hour."

"Applying these characteristics to a wind tunnel will help duplicate the extreme conditions met by missiles and other space craft of the future upon re-entry into the earth's atmosphere."

A First

Pensacola Junior College in Florida will become the first junior college in the nation to install a nuclear reactor.

President Henry L. Ashmore announced that a subcritical nuclear reactor using "enriched fuel" will be put into operation at the college for the preliminary training of nuclear scientists. Built by Lockheed Nuclear Products in Atlanta, the reactor will be used for the training of students in the application of nuclear engineering fundamentals.

Hot Under The Collar!

"Thermal barrier" temperatures are simulated in a nose cone testing device at the National Aeronautical and Space Administration's Langley Research Center in Virginia. Heat produced by 225 2500-watt tubular General Electric quartz infrared lamps in the cylindrical radiator reaches 3100° F., about a third as hot as the surface of the sun. Such tests facilitate the nation's efforts to overcome the re-entry problems faced in rocket, missile and space-vehicle programs.

Star Gazers Congregate

Top level astronomers of the country interested in improving the teaching of astronomy will be among the participants in a University of Illinois research project. The astronomers will come to the University for a two-month period during the summer of 1961 to write and test updated and expanded educational materials in astronomy to be taught to elementary school pupils.

The objective of the research is to find out how well grade school children can grasp concepts of modern astronomy and to develop and test instructional materials for use by elementary teachers.

Science Films Produced for College

Two new sound motion pictures for use in college science and engineering classes have just been produced by Bell Telephone Laboratories. The films, entitled "Memory Devices" and "Similarities in Wave Behavior," were prepared under the guidance of Bell Leboratories scientists and engineers, and are available on free loan through local Bell Telephone Company offices.

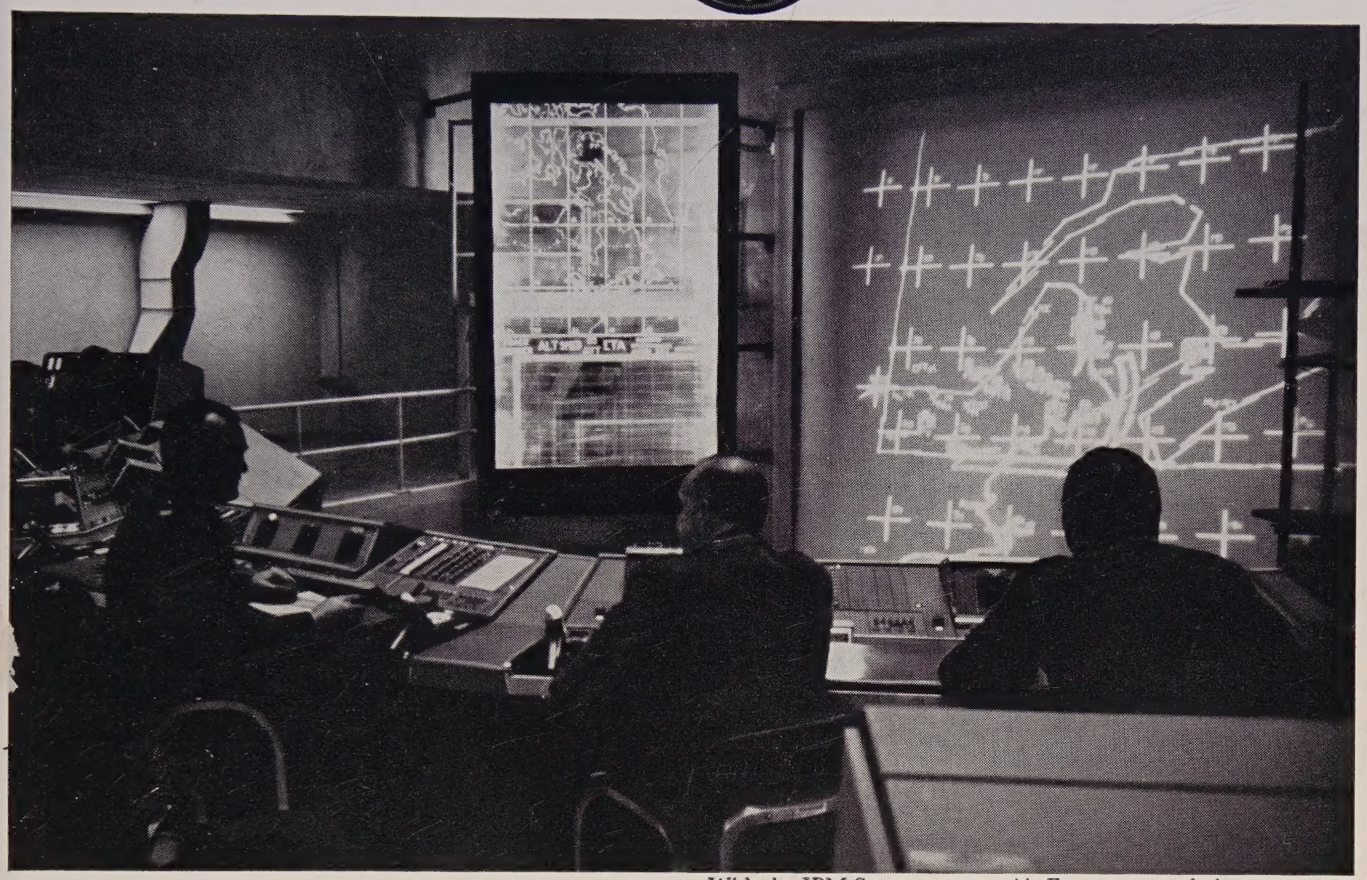
"Memory Devices" (16mm, sound, color, 27 minutes) is a narration film which shows information storage devices used in modern computing machines memories and explains how binary information is stored in them. Basic concepts and terms are explained and examples of mechanical, electromechanical, magnetic, electrostatic and photographic memories are described.

"Similarities in Wave Behavior" (16mm, sound, black and white, 26½ minutes) is a demonstration - lecture by Dr. J. N. Shive of Bell Laboratories. He discusses the similarities that exist in the behavior of waves in various mechanical, electrical, acoustical and optical wave systems. Using specially built torsion wave machines, he demonstrates the reflection of waves from free and clamped terminations. The ideas of superposition, standing waves, and resonance are shown in slow motion. Energy lost by impedance mismatching is demonstrated and calculated in simple terms, and then Dr. Shive shows how quarter-wave and tapered-section matching transformers act to reduce energy loss.

Try That Again

The sentence, "The spirit is willing, but the flesh is weak," was fed into an electronic computer during experiments in machine translation. The machine translated it into Russian and, when a translator put it back into English it came out, "The liquor is still good, but the meat has gone bad."

If your sights are set on electronics–



With the IBM Sage computer, Air Force personnel view computer-generated displays projected in the Command Post.

–you'll find **Photography at Work** with you

The engineer working in electronics finds photography one of his most valuable tools. For example, he uses camera and film to capture and study the fleeting transient on the oscilloscope face.

X-rays and film provide him with a check on the internal integrity of sealed components. Even intricate circuits can be printed and miniaturized by photographic methods.

There's hardly a field on which you can set your sights where photography does not play a part in simplifying work and routine. It saves time and costs in research, on the production line, in the engineering and sales department, in the office.

So in whatever you plan to do, take full advantage of all the ways photography can help.

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One of a series

Interview with
General Electric's Earl G. Abbott,
Manager—Sales Training

Technical Training Programs at General Electric

Q. Why does your company have training programs, Mr. Abbott?

A. Tomorrow's many positions of major responsibility will necessarily be filled by young men who have developed their potentials early in their careers. General Electric training programs simply help speed up this development process.

In addition, training programs provide graduates with the blocks of broad experience on which later success in a specialization can be built.

Furthermore, career opportunities and interests are brought into sharp focus after intensive working exposures to several fields. General Electric then gains the valuable contributions of men who have made early, well-considered decisions on career goals and who are confidently working toward those objectives.

Q. What kinds of technical training programs does your company conduct?

A. General Electric conducts a number of training programs. The G-E programs which attract the great majority of engineering graduates are Engineering and Science, Manufacturing, and Technical Marketing.

Q. How long does the Engineering and Science Program last?

A. That depends on which of several avenues you decide to take. Many graduates complete the training program during their first year with General Electric. Each Program member has three or four responsible work assignments at one or more of 61 different plant locations.

Some graduates elect to take the Advanced Engineering Program, supplementing their work assignments with challenging Company-conducted study courses which cover the application of engineering, science, and mathematics to industrial problems. If the Program member has an analytical bent coupled with a deep interest in mathematics and physics, he may continue through a second and third year of the Advanced Engineering Program.

Then there is the two-year Creative Engineering Program for those graduates who have completed their first-year assignments and who are interested in learning creative techniques for solving engineering problems.

Another avenue of training for the qualified graduate is the Honors Program, which enables a man to earn his Master's degree within three or four semesters at selected colleges and universities. The Company pays for his tuition and books, and his work schedule allows him to earn 75 percent of full salary while he is going to school. This program is similar to a research assistantship at a college or university.

Q. Just how will the Manufacturing Training Program help prepare me for a career in manufacturing?

A. The three-year Manufacturing Program consists of three orientation assignments and three development assignments in the areas of manufacturing engineering, quality control, materials management, plant engineering, and manufacturing operations. These assignments provide you with broad, fundamental manufacturing knowledge and with specialized knowledge in your particular field of interest.

The practical, on-the-job experience offered by this rotational program is supplemented by participation in a manufacturing studies curriculum covering all phases of manufacturing.

Q. What kind of training would I get on your Technical Marketing Program?

A. The one-year Technical Marketing Program is conducted for those graduates who want to use their engineering knowledge in dealing with customers. After completing orientation assignments in engineering, manufacturing, and marketing, the Program member may specialize in one of the four marketing areas: application engineering, headquarters marketing, sales engineering, or installation and service engineering.

In addition to on-the-job assignments, related courses of study help the Program member prepare for early assumption of major responsibility.

Q. How can I decide which training program I would like best, Mr. Abbott?

A. Well, selecting a training program is a decision which you alone can make. You made a similar decision when you selected your college major, and now you are focusing your interests only a little more sharply. The beauty of training programs is that they enable you to keep your career selection relatively broad until you have examined at first hand a number of specializations.

Furthermore, transfers from one General Electric training program to another are possible for the Program member whose interests clearly develop in one of the other fields.

Personalized Career Planning is General Electric's term for the selection, placement, and professional development of engineers and scientists. If you would like a Personalized Career Planning folder which describes in more detail the Company's training programs for technical graduates, write to Mr. Abbott at Section 959-13, General Electric Company, Schenectady 5, N. Y.

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